



## VIDEO VIEWING GUIDE

1. According to the video, how are El Niño and sickle cell anemia alike?
2. Draw a causal-loop diagram showing some of the components of El Niño.
3. What was the limiting percent mentioned born with sickle cell anemia in equatorial West Africa?
4. In the feedback cycle described in the sickle cell anemia loop, what do the  $NN$ ,  $SN$ , and  $SS$  represent?
5. What is meant by the expression “the butterfly effect?”
6. What is meant by equilibrium in a feedback system?
7. What are some of the processes scientists use to check for the El Niño effect?

**H6.1**

page 2 of 2

## THE BUTTERFLY EFFECT

**W**hile the butterfly effect may or may not be real, you can have some fun thinking creatively about “what might be.” Is everything truly related to everything else?

1. Select two things that are seemingly unrelated. Write them on a sheet of paper, one at the top, the other at the bottom.
2. Pass this paper to a classmate and ask the classmate to connect the top event to the bottom one with a series of causal events/items.



## THE JOKE'S ON YOU—SIMULATION DESIGN

**T**his simulation uses each member of your class to play the role of two separate people and is based on the assumptions stated in your text. The random number feature of your calculator will be used to select the people who will hear the joke in each new time period. Data will be recorded in **Figure 1**.

Here's a design based on a class size of 35 students. Be sure to change the 35 to whatever is correct for your class before you do the simulation. Remember, each student is two different people in the simulation.

- Before starting, assign each student two “names” (integers) so that each integer from 1 through 70 belongs to someone. Person number 1 is the person who knows the joke at the start of the simulation.
- For time period 1, person 1 uses a calculator to select a random integer from 1 to 70, inclusive. For example, syntax such as `randInt(1, 70)` may be appropriate.
- If the person whose number is shown has not yet heard the joke, person 1 “tells the joke” to her. Complete the  $n = 1$  row of your data table. (For a class of 35, the  $n = 1$  entry in column 2 will probably be 2.)
- For each remaining time period, have each person who has already heard the joke at the start of that period generate a random integer from 1 to 70, inclusive, and “tell the joke” to each indicated person if that person had not heard it at the start of that time period. Update your data table. Repeat this step until everyone has heard the joke.

Using the instructions above, complete Items 3–7 of Supplemental Activity S6.4, or carry out your own analysis of the data as suggested in Activity 5 of your text.

Time period ( $n$ )	Number who have heard the joke ( $Q(n)$ )
0	1
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

**Figure 1.** Table for recording simulation data.





## UNIT PROJECTS

1. Investigate data for a particular disease and examine possible policy decisions via your simulation model.
2. Build a predator-prey model based on logistic (rather than exponential) underlying behavior. Compare the results with those in Individual Work 7.
3. Research competitive hunter biological systems and simulate their behavior.
4. Research symbiotic biological systems and simulate their behavior.
5. Research homeostasis in organisms. Select one subsystem of one organism and model the key components of its feedback control.

