A PILOT DVD PROJECT

CONTAGION: THE SPREAD OF DISEASE

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Activity: Getting a Disease is Just a Throw of the Dice

Time Frame: 50 minutes (may run to 100 minutes with extensions)

Materials: Cups of three different colors for each student, 1 die per student (multicolored for the extensions)

Teacher Directions:

- Watch Lecture 1 Chapters 4 & 5
  - Discuss living conditions and the state of medical science during the 14th century
    - Discuss methods of sanitation and water purification
    - Discuss historical standards of personal hygiene
    - Discuss germ theory and how prior to the 19th century the causes of disease were generally misunderstood
    - If possible coordinate with the history teacher
- Watch Lecture 1 Chapters 15 & 16
  - Discuss the possible causes of illness in the picnic scenario
    - Bacterial/Viral contamination
    - Poisoning
    - Drug overdose
    - Toxins in the food
  - Ask: Why the family and friends of the sick individuals did not get sick?
  - Ask: How this is present situation compares with what might have happened at similar picnic taking place in the 14th century?
- Watch Lecture 2 Chapters 18 & 19
  - Ask: How do bacteria spread? How did the bacteria spread in the airplane? How do you get the flu?
- Activity – See Student Worksheet
  - Teacher Notes
    - The colors of the cups may change due to availability and cost.
      - If you find it necessary to change the cup colors either change the directions on the handouts prior to copying or be very explicit about the changes in your classroom.
    - Desk arrangement may vary and you may have to be creative in setting up infection zones in auditoria or non-standard classrooms.
    - Specifically ask: How does the rate at which infection spreads compare between simulations I-A and I-B.
    - In graphing the results for the simulation report you should suggest the use of different colors for each condition (healthy, infected, immune).
    - While you can use any lab/simulation report format you customarily employ we would strongly urge that you infuse writing into the conclusions and require that they be at a minimum 1-2 paragraphs per simulation.

- Watch Lecture 4 Chapter 5
  - Ask: What could affect the emergence of a new virus?
  - Ask: How does this relate to E-bola and the “Outbreak” scenarios?
- Watch Lecture 4 Chapters 14-18
  - Ask: What is the difference between a pandemic and an epidemic?
  - Ask: Why do you need a new flu vaccine every year?

Student Directions: See Attached “Getting a Disease is Just a Throw of the Dice”

Evaluation:

- Lab report (which will vary according to the collected data).
- Students can present their data.
- The following questions can be used either to guide the students in preparing their reports or as follow-up discussion questions after the reports are presented.
  - As an individual how does the change between simulation I-A and I-B change the likelihood of getting the flu?
  - When comparing simulations 1-B and II, how does the time of contagion affect the epidemic?
  - When comparing simulations I-B and III, how does exposure distance affect the epidemic?
  - How does proximity in the classroom affect the transmission of airborne diseases?
  - What other factors affect the “intensity” or length of an epidemic?
  - Why do epidemics “burn-out?”

Extensions: Simulations IV and V

Web Connections:

- http://www.cdc.gov/default.htm
- http://www.cdc.gov/ncidod/diseases/flu/fluvirus.htm
- http://www.nih.gov/
- http://www.pbs.org/wgbh/amex/influenza/

Getting a Disease is Just a Throw of the Dice

You will be conducting several simulations of an epidemic caused by the spread of a new strain of the flu among a group of unvaccinated people. Each of you starts as a healthy, never-infected individual. You remain healthy unless you get infected by the flu. If you recover from the flu you will develop immunity to further infections of this strain of the flu.

There are many variables that can influence the spread of a disease caused by any particular pathogen. Among these variables are the length of time that it is contagious, the ease with which you can catch it (infectivity) and the distance at which you can catch it. In addition we can also model the lethality of a disease and the susceptibility of sub-populations.

For each simulation you will collect data and record it in a table in which the rows represent time intervals in the simulation. The total of any given row must equal the total number of people in the class, assuming a non-fatal flu.

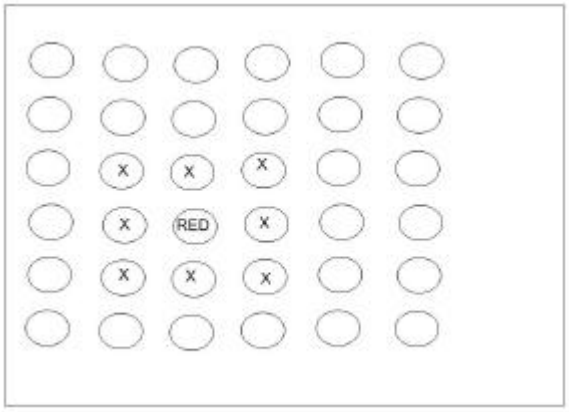
You have been given a die and 3 colored cups.
The cups let everyone in the class visually follow the spread of the disease.
A white cup represents a person who is healthy and never infected.
A red cup represents a person sick with the flu.
A blue cup represents a person who has recovered and is immune to the flu.

Therefore, with the exception of one of you, all the cups should be stacked so the white cup is on the outside.

Check under your desks for the “red” tag of the flu. The one student with that tag should change his/her outer cup to red.

Simulation I-A

If we assume that a flu is infectious for 1 cycle and moderately infectious to any desk in contact with an infected individual's desk (all 8 desks-see diagram below).



Each of you at the desks adjacent to the "red" cup should roll your die. If you roll a **1**, or a **2**, sorry, you get the flu and should stack your cup so that red is on the outside. If you roll a **3, 4, 5**, or **6** you were lucky enough not to get the flu on this exposure. Keep your white cup on the outside. This flu has an infectivity of 33% (i.e. 1/3 of those exposed get sick).

As a class, count and individually record the number of sick (red cup) and healthy (white cup) students. Record this as cycle 2. After the cycle is completed the original student with the red cup should re-stack his/her cup so that the blue cup is on the outside. He/she has recovered and is now immune.

As you begin cycle 3, each student adjacent to a desk with a red cup should roll his/her die. Again, if you roll a **1** or a **2** you get the flu and you should stack your cup so that red is on the outside. If you roll a **3, 4, 5**, or **6** you remain healthy and do not change your cup. If you have a blue cup you can't catch the flu anymore, even if you are next to someone with a red cup. Don't bother to roll your die.

After you record the class counts, those who turned "red" during cycle 2 should re-stack their cups to show they are recovered (blue).

Continue until most of the class is "blue" or you reach cycle 9. Record your data on the data sheet each time.

Simulation I-B

We will repeat the simulation exactly as in I-A except that we will vary the infectivity of the flu, increasing the likelihood that you will get sick on exposure. If you roll a **1, 2, 3** or **4** you will get sick, a roll of **5** or **6** results in your remaining healthy. This flu has an infectivity of 67% (i.e. 2/3 of those exposed get sick). Observe the spread of the flu (red cups) through the population, being sure to collect and record the data.

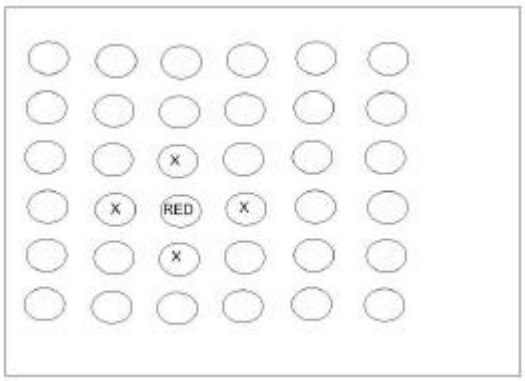
Simulation II

We will repeat the simulation. However in this case, we will examine the effect that length of contagion has on the pattern of epidemic progression. The infectivity will again

be set at 67% (i.e. a roll of **1, 2, 3** or **4** means you get the flu, a **5**, or **6** means you stay healthy). Once you get the flu you stay infectious for 3 cycles.
Record the data for simulation II in the data table.

Simulation III

We will repeat the simulation. However in this case, we will examine the effect that the distance, at which the disease is contagious, plays in the pattern of epidemic progression. Infectivity will be set at 67% as in I-B and II, the length of time you stay infectious will return to 1 cycle, as in simulation I-B. The only individuals who can get sick are those in the 4 desks closest to a sick (red-cup) individual. (Those next to or immediately in front of or behind an infected person-see diagram below). Be certain you record all the data in the data table.



Simulation Report

Reports should include at least 3 graphs.
Graph 1 should compare the number of individuals in each of the 3 categories in cases I-A and I-B
Graph 2 should compare the number of individuals in each of the 3 categories in cases I-B and II.
Graph 3 should compare the number of individuals in each of the 3 categories in cases I-B and III.
In all cases the X-axis should be the number of cycles (time).

Interpret each graph in light of what you understand about epidemics and your experience with the real flu.

Extension-Simulation IV
For this simulation we will vary the susceptibility to infection. The die you were initially given are multicolored. If you have a yellow die you represent an infant. A white die represents an elderly person. Both infants and the elderly are more susceptible to infection that healthy adults.

As we repeat the simulation, we will return to the basic conditions where all 8 adjacent desks are exposed. In this case, however when you role the dice not only will your disease state be determined by the number on the die, but also by the color of that die.

If you are an infant (yellow die) you get sick if you roll a **1, 2, 3** or **4**.
If you are an elderly person (white die) you get sick if you roll a **1, 2, 3, 4** or **5**.
If you are a normally healthy adult (all other colors) you get sick if you roll a **1, 2**, or **3**.

In addition, while healthy adults recover from the flu in 1 cycle, infants and the elderly remain sick for 3 cycles.

Again carefully observe the spread of the disease and record all the data on the data sheet.

Extension Simulation V

This last simulation is similar to simulation IV, except here we will include the possibility of mortality. At each cycle once an infant or elderly person has the flu before they are recovered they will continue to roll the die. If they roll a 1, they die. Record all the data in the table.

DATA SHEETS

I-A

Cycles	Flu	Healthy-Never Infected	Healthy-Recovered	Total
1	1			
2				
3				
4				
5				
6				
7				
8				
9				

I-B

Cycles	Flu	Healthy-Never Infected	Healthy-Recovered	Total
1	1			
2				
3				
4				
5				
6				
7				
8				
9				

II

Cycles	Flu	Healthy-Never Infected	Healthy-Recovered	Total
1	1			
2				
3				
4				
5				
6				
7				
8				
9				

III

Cycles	Flu	Healthy-Never Infected	Healthy-Recovered	Total
1	1			
2				
3				
4				
5				
6				
7				
8				
9				

IV

Cycles	Flu	Healthy-Never Infected	Healthy-Recovered	Total
1	1			
2				
3				
4				
5				
6				
7				
8				
9				

V

Cycles	Flu	Healthy-Never Infected	Healthy-Recovered	Total
1	1			
2				
3				
4				
5				
6				
7				
8				
9				