EDUCATIONAL OUTREACH
FLORIDA POLYTECHNIC UNIVERSITY

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MODELING THE TRANSMISSION OF DISEASE

Flattening the Curve

Overview:

Diseases are any harmful deviation from the normal structural or functional state of an organism, generally associated with certain signs and symptoms and differing in nature from physical injury. Infectious diseases or pathogens are disorders caused by organisms — such as bacteria, viruses, fungi, or parasites. Many organisms live in and on our bodies. They are normally harmless or even helpful. But under certain conditions, some organisms may cause disease. A communicable disease is one that is spread from one person to another through a variety of ways. These infectious diseases commonly spread through the direct transfer of bacteria, viruses, or other germs from one person to another. This can happen when an individual with the bacterium or virus touches, coughs, or sneezes on someone who isn't infected. Five common way disease are spread include:

- Airborne through the nose, mouth (or even eyes) to others
- Hands to food
- Food to hands to food
- Infected skin to skin (contact and surfaces)
- Animals to people

Vaccines help prevent contracting a disease but are not a cure. Vaccines are product that stimulates a person's immune system to produce immunity to a specific disease, protecting the person from that disease. Vaccines are usually administered through needle injections but can also be administered by mouth or sprayed into the nose. Some diseases have cures in the form of natural antibiotics, synthetic antibiotics, antivirals, antifungals, antitoxins, vitamins, gene therapy, surgery, chemotherapy, and radiotherapy to name a few methods.

The word curve in the term “flattening the curve” doesn’t refer to the true number of cases. Rather, it refers to the projected number of people who will contract the disease. More specifically, the curve is two curves in a chart that demonstrate the spread of the virus with and without protective measures, such as social distancing. A dotted line through the curves on the graph represents the peak capacity of the health care system to care for a projected number of patients. Flattening the curve means slowing the spread of the disease. Today you will investigate an unknown pathogen like epidemiologists. Epidemiologists are public health workers who investigate patterns and causes of disease and injury. They seek to reduce the risk and occurrence of negative health outcomes through research, community education and health policy.

Learning Outcomes

-Students will describe the spread of disease and ways outbreaks can be avoided or prevented.
-Students will explain the dynamics of the transmission of diseases by taking part in a "hands-on" simulation.
-Students will analyze and identify the source of the pathogen
-Students will develop a theory to flatten the curve

Materials

- Clear plastic cups (16 oz preferred)
- Tap water
- Phenolphthalein solution or strips*
- **So**dium carbonate Na_2CO_3 (aka washing soda)**
- Index Cards
- Pen or pencil
- Gloves
- Goggles

The Activity

This hands-on activity simulates the spread of disease. A pre-activity discussion about diseases, viruses, vaccines, and cures is recommended to develop prior knowledge for students.

Lab Safety rules should be reviewed.
Phenolphthalein can irritate the eyes and skin. Alert students to avoid spilling and warn them to NEVER drink what is in the plastic cup.

Script:

A: “Good morning/afternoon class. Has anyone been watching the news? I saw a report today that people are getting sick, but doctors don’t know what it is or how people are getting sick. It is spreading around the country. The illness is instant. Scientists don’t know how it started or how it is being spread. It could be in the air, the water, our food. They still don’t know how it is being transmitted between people- breathing it in, body fluids, physical contact, sharing food/drink. There are so many possibilities. No need to panic. The Center for Disease Control and Prevention (CDC) has advised everyone to go on

with their daily lives but practice caution. So! Let's start our day with a laboratory experiment to understand diseases a little better."

(Perform simulation 1)

B: "Unfortunately, it seems as if the pathogen has made it to our town. The good news is that there is a test for the pathogen. The bad news is that epidemiologists don't know exactly how it is being transmitted. They do say to go on with your normal routine but take precautions such as washing your hands and covering your mouth when you cough. As they learn more about the pathogen, scientists are trying to create a vaccine. In the meantime, doctors don't have a cure, but are treating the symptoms.

I have been able to secure the testing solution. I will now test each of you for the pathogen. I will place one drop of the testing solution in your cup. If it remains clear, you do not have the pathogen. If it turns pink, you've been infected."

(Perform simulation 2)

C: "Great news. The CDC now knows that the pathogen is spread through skin contact. This can be through direct skin contact or secondary from surfaces that people have touched. They suggest that people refrain from shaking hands, hugging and any other skin-to-skin contact. Proper skin covering is also advised. Scientists have also created a vaccine. While it is not a cure, it does reduce the changes of you contracting the disease. There still is no cure. Doctors are treating the symptoms and the hospitals are currently unable to take more patients."

Part 1

Simulation 1:

1. Read part A of the script.
2. Let participants know they are going to model the transmission of a disease by exchanging some of their test tube's contents with that of other participants. This "exchange" represents daily activity- talking, touching, hugging, sneezing, sharing food/drink, etc.
3. Distribute prepared cups randomly to the class. Make a mental note of who receives the test tube containing the "pathogen".
4. Have students wear gloves and goggles.
5. Explain to the students every time they encounter another student, they are to exchange some of the liquid from their cups. After choosing a classmate to "share" liquids with, one member of the pair pours all the water from his or her cup into the partner's cup. Then the partner will pour half of the combined liquids back into the first member's cup. This way the students have mixed their two liquids, but in the end, each has the same amount they started with.
6. Have participants walk around the room with their cups for 2 minutes. Every time they encounter another student, have them exchange fluids and record the exchange on a note card.

7. After two minutes, tell the students to stop and return to their seats.

Part 2

Simulation 2

1. Read part B of the script.
2. Now it's time to test for the imaginary infection. Put a drop of phenolphthalein in each cup. If the fluid turns pink, the cup is "infected".
3. Have the students record the number of infected on their data table and who they suspect spread the disease.
4. Discussion- students should look at their note cards and discuss contact tracing. Can the students figure out who patient zero was? Their challenge is to collect data that will help them trace the path of the epidemic and locate the original carriers.
5. Now that the students know that the virus is out there, run a second simulation for 2 minutes again where the student exchange fluids with the students they encounter, recording the encounter on their note card.
6. After 2 minutes, have the students return to their seat. Record the number of infected students.
7. Discussion- Work as epidemiologists to contact trace the pathogen to figure out who patient zero is. Discuss if they changed their behavior for the second simulation now that they knew that some of their classmates were infected. Discuss ways in which the community can help prevent the spread of the pathogen. As a group, use the data to try to deduce which individual was the original carrier of the disease. Why might it be important to locate the source of infection? What difficulties arise in trying to collect and interpret data? Note that the simulated disease has a 100% rate of infection that appears immediately under testing. Have students come up with theories on how this pathogen is being spread.

Part 3

Simulation 3- Flattening the Curve

1. Read part C of the script.
2. Run a third simulation. This time have the students practice the ways in which they decided the community could help prevent the spread of the pathogen. (Hopefully they avoid each other). Have them record any encounter on their note card.
3. After 2 minutes, have the students return to their seats. Record the number of infected students.
4. Discuss- Work as epidemiologists to contact trace the pathogen to figure out who patient zero is. Discuss if they changed their behavior for the third simulation given more information and a

community plan. Why is it important to flatten the curve? What should be done when/if the curve is flattened?

5. Reveal patient(s) zero
6. *Explanations*: Have students explain how the activity was a good example of how viruses spread and how their investigative work is like what an epidemiologist does. Have students explain their approach to determining who the original infected persons were. Ask students to come up with a plan for the community to flatten the curve. Ensure they use evidence to support their argument.

Simulation #	Number Infected	Suspected Spreader
1		
2		
3		
4		

Assessment

1. Name 3 diseases that are the result of infection
2. Graphically represent data created in a classroom simulation
3. Explain the concepts of biohazard, quarantine, epidemic, and pandemic
4. Name ways that infectious disease can be prevented, controlled, or cured
5. Explain how preventive measures help defend against infection

Extensions

1. Give some examples from past and recent history- Cyprian Plague, Bubonic Plague, Cholera Pandemic, Smallpox, Guinea worm parasite, Spanish Flue, Zika Virus, Swine Flu, HIV/AIDS, SARS, COVID-19
2. Refer to pop culture (movies, books, tv shows) with a discussion on artistic license vs science
3. Visit the story of Typhoid Mary
4. Run additional simulations after students have been "vaccinated" by neutralizing the pH of the cup (Simulation 4)
5. Dig deeper and discuss the life cycles of viral and bacterial diseases
6. Challenge students create a strategy to inhibit viral infection (vaccine alternative)
7. Use simulation software to create your own scenarios.

Additional Resources

1. Center for Disease Control and Prevention
2. Flattening the Curve
3. Play Solve the Outbreak from the CDC

Teacher Notes

1. When preparing the simulation, fill the cups ¼ with tap water
2. To infect a cup, place 1-2 drops of ammonia or 1 teaspoon of sodium carbonate. Keep track of the infected cup and note who you give it to. I try to choose one of the quieter students and a well-rounded student. Students tend to choose the louder or more popular student as patient zero.
3. Suggest 1 infected per 15 students
4. Get creative with your storytelling. The more dramatic (and realistic) the better. Modify the script to meet your needs.
5. Neutralize the solution in your cups before disposing

*Can be purchased from lab supply company or online companies like Amazon. Liquid gives the students a better visual effect than the strips.

**Ammonia can be substituted for Sodium carbonate Na_2CO_3 (aka washing soda). Mix 1-2 drops to "infect" a sample

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