Zombie Apocalypse – How Disease Spreads through a Population

TEACHER NOTES – TI-84 Plus CE

Objectives

- Students will investigate the spread of a disease through a population, using zombies as a model.
- Students will learn or review the basic functions of various parts of the human brain.
- Students will investigate and discuss factors dealing with immunity and vaccines.

Vocabulary

- Epidemiologist
- Cerebellum
- Hypothalamus
- Frontal Lobe
- Amygdala
- Infection
- Vaccine
- Virus
- Virulence
- Inoculation

About the Lesson

- This lesson introduces the concept of a disease spreading through a human population using fictional zombies as the agent of infection.
- Teaching time: one to two 45 minute class period(s)
- As a result, students will:
  - Interpret graphs to make predictions.
  - Use simulations to understand the symptoms of a fictional disease and see how the disease moves through a population.

Activity Materials

- Compatible TI Technologies:
  - TI-84 Plus CE *with the latest operating system*

Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

- Image1.8ca
- Image2.8ca
- Image3.8ca
- Image4.8ca
- Image5.8ca
- Image6.8ca
- Image7.8ca
- ZombieApocalypse.8xp

Tech Tip: Make sure when sending the program file ZombieApocalypse.8xp to your TI-84 Plus CE calculators that the program, and image1, image2, image3, image4, image5, image6, and image7 are also sent. If the images aren't sent, the program will use any images already stored in those image locations on your calculator which will make for a strange experience.

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Background

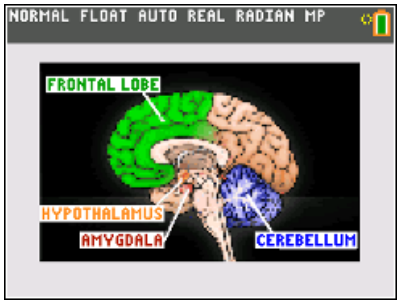
There are highly stylized images of zombies in this file. If you have students who have concerns with this activity, you may not want to use it. Explain to students that although zombies do NOT exist, they serve as a fun, pop cultural model that allows us to talk about disease and the spread of disease. Many television shows and movies have zombies as a part of the storyline, so they will serve as a way to engage students as they are introduced to the concepts of disease and the patterns and parameters that are characteristic of the spread of disease.

This particular activity starts by giving students the scenario of a virus spreading through a population. It goes on to describe the symptoms of the infection and wraps up with an animated simulation of the disease spreading through a population demonstrating an associated graph generating a characteristic 's' curve.

It is likely that students will question the mechanism of transmission. This activity depicts the zombie virus being transmitted through airborne saliva droplets from coughing and/or sneezing. Movies and television programs have treated the zombie "infection" in different ways. Students will ask if zombies get infected from bites from other zombies. Those kinds of questions are great opportunities to discuss how the spread of the disease would be different from the airborne model this activity portrays.

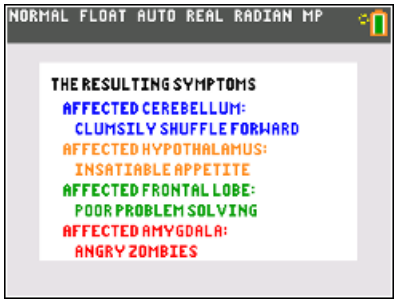
Move to the page with the image of a brain (Shown to the right)

1. Students will read the above scenario whereby a newly discovered virus has been infecting humans, causing them to exhibit zombie-like symptoms. There are four areas of the brain which the virus affects –



   - The Cerebellum: Balance and Coordination
   - The Hypothalamus: Appetite
   - The Frontal Lobe: Intelligence and Problem Solving
   - The Amygdala: Anger and Rage

The Resulting Symptoms

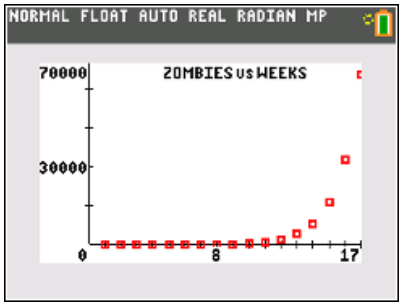


   - **Affected Cerebellum**: Zombies clumsily shuffle forward.
   - **Affected Hypothalamus**: Zombies have insatiable appetites.
   - **Affected Frontal Lobe**: Zombies are poor problem solvers.
   - **Affected Amygdala**: Zombies aren't nice. They are full of rage.

2. After students review the parts of the brain, ask students: *Can you think of some real diseases that affect the brain?* **Sample answers: Multiple Sclerosis, Parkinson's disease, Alzheimers disease, Epilepsy**

3. Students should navigate to the page that allows them to witness a human turning into a zombie. Direct them to observe how the brain changes with each stage.

Move to the page with the graph labeled "Zombies vs. Weeks"



4. This page plots a graph, which students may use to see the rates of infection in the first months after the onset of the disease. Notice this graph appears to have an exponential pattern.

For discussion, ask students:

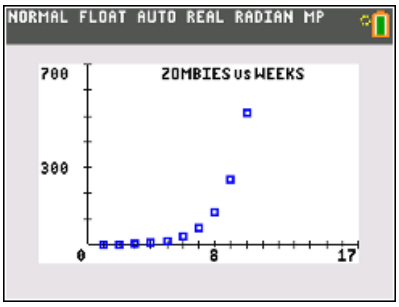
- *What predictions can you make based on this data?*
  Sample answers: It appears that after week 10, the number of zombies is increasing at a very fast rate. Or the numbers of zombies seems to increase exponentially
- *How long they believe this pattern will continue?*
  Answers will vary, this is an opinion question.
- *What factors will affect the pattern?*
  Sample answers: the number of humans infected or the number of humans available as a food source.

Have Students answer questions Q1 – Q4 based on the Zombies vs Weeks graphs

Q1. The greatest rate of infection occurred between week _____and week _____.
Answer: Between week 16 and week 17.

Q2a. What is the approximate infection rate between week 1 and week 8?
Answer: Relatively low; the graph makes it look like zero.

Q2b. Now move to the graph on the following page (pictured right with blue plots). What is the approximate infection rate between week 7 and week 8?
Answer: ~40 zombies per weeks



We suggest you accept answers between 20 to 60 zombies per week, since students will only be able to look at the graph and approximate the rate of change

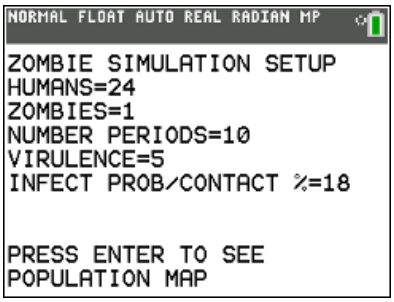
Q3. If the trend were to continue, predict what the number of zombies will be after the 25th week.
Answer: This is hard to determine from the graph, however a reasonable answer would be well into the millions—if the exponential model continued to hold true.

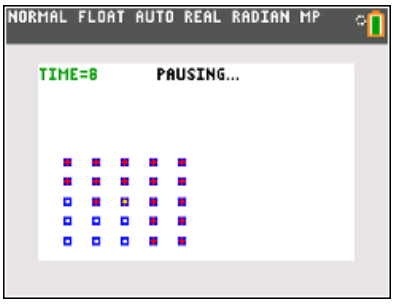
Q4. Explain what you believe will actually be happening with the rate of zombie production after 30 weeks.
Answer: The rate should slow considerably because of fewer people available to infect. This is not an obvious answer to most students.

5. The rate of infection of any disease will eventually decrease because of many different factors. For this activity, the main factors are lack of food (healthy humans) and lack of additional targets to infect (again, healthy humans). For real epidemics or diseases those factors may include the development of a vaccine or the elimination of a vector (the source that carries and distributes the pathogen) such as mosquitos, rats, or other organisms. Historically, factors such as sanitation have helped to control the rate of disease spread. What other factors can you think of?

Move to the page titled, "ZOMBIE SIMULATION SETUP"

6. This page introduces students to the idea that the zombification rate is limited by certain factors such as a food source, virulence (the measure of how effectively a disease- causing agent can spread through a population) and natural resistance to the virus in some humans. Students will use a simulation which offers a visual of the spread of the zombie virus. An associated graph is produced during the simulation which shows the inverse relationship between humans and zombies. Ask students to discuss the other factors that could affect the limitations of a disease and why the relationship between the numbers of humans and zombies is inverse. Discuss why the virus doesn't wipe out all humans in the simulation (natural resistance and lower susceptibility).



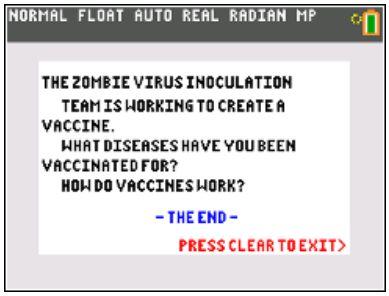


NOTE: *The last two pages of the teacher notes include sample screen shots for virulence from 1 through 10. Use these for comparison purposes. This simulation is based on probability calculations, and uses a relatively small population size. The results will vary between students running the sim with the same virulence settings. However, in general, patterns should be obvious between multiple groups of students.*
It is suggested that each student in a group do the simulation with a different virulence number. One should use a virulence number of 1, another use 10, and then some between 1 and 10. Have them compare and contrast their different graphs.

Tech Tips: Students should read the messages on the simulation for instructions on how to proceed. The sim takes approximately 2 to 5 minutes to fully run. If students see "Defragmenting" appear, they may need to run the sim again. Defragmenting is cleaning up resources on the calculator. It is normal behavior.

Move to the last page (Marked *"–The End--"* at the bottom)

7. Students will answer questions on the student worksheet about the simulation and the impact of the adjustments they made to the level of virulence. Students should notice that as virulence increases the rate of infection increases until there are no longer susceptible humans to infect. Ask students why some humans become infected with the virus and some do not. There is natural immunity to viruses and bacteria. Biodiversity serves as a mechanism to ensure the survival of a species. This includes resistance to disease. Use the last page (pictured to the right) to wrap-up the activity with a discussion on diseases and vaccines that are real, and relevant to students.



Have Students answer questions Q5 – Q11 based on the Zombie population simulation

Q5. In the graph, "time" is the independent variable, but there is no actual UNIT of time indicated. What do you think would be an appropriate unit of time for the spread of the Zombie Virus?
Answer: Weeks or months would be a good answer.

Q6. Estimate the point at which the number of zombies and the number of humans are equal? What variable would affect this point?

Answer: With the virulence set at 3, the numbers of each should be close to being equal at 10 weeks. (answers will vary)

Q7. Based on the graph of humans and zombies, which do you think is the relationship between the two populations?

A. Inverse
B. Direct
C. There appears to be no relationship.

Q8. What effect did changing the virulence have on the rate of Zombie Virus infection?

A. As virulence increased, the rate decreased.
B. As virulence increased, the rate increased.
C. As virulence increased, the rate did not change.

Q9. Although the Zombie Virus isn't a real concern for us YET, name another disease that you think has a pretty high degree of virulence.
Answers: Diseases such as influenza, common cold, chicken pox, etc.

Q10. What if a new "strain" of the Zombie Virus appeared that was almost the same as the original virus, except that it did not affect the cerebellum? Predict what the result would be.
Answer: The zombies would have more muscle coordination and may be able to better catch their prey!

Q11. What if the virus changed again, and neither cerebellum nor the frontal lobe were affected? Predict the results.
Answer: Now, in addition to being more physically coordinated, they would also be able to think and reason much more clearly. Not a good scenario for the 'non-zombied' humans!

Wrap Up

Students will have various results depending upon the virulence settings they used and where the first infection takes place (i.e., the corner of the population grid vs. the middle). Have students compare their graphs and discuss why the results may be different.

Assessment

- Students will answer questions throughout the lesson to ensure understanding of the process of disease spread.

The next page contains sample screen shots for virulence settings from 1 through 10. Use these for comparison purposes.

Sample Data- *Screen shots with different virulence settings: 1 through 10. Even if students choose the same virulence settings, they will likely see variation in their data. This is a result of a smaller population size and where the first zombie is located. For example, A zombie that starts in a corner only has three potential humans to infect. Alternatively, a zombie that is located with eight humans around it, has a higher probability of infecting one of them. This makes for a rich discussion of quarantine choices, geography, and limitations of simulations to model the real world.*