TI-84 Plus C Silver Edition

**TEACHER NOTES**

# Zombie Apocalypse Part I

## Zombie Apocalypse Part 1: How Disease Spreads through a Population

*Adapted from an activity © 2013 Texas Instruments*

**Help: http://www.cemetech.net/forum or stemzombie1@cemetech.net**


### Science 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

### 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 45 minute class period
- 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.

### What Page Am I On?

When you see the **?** (question mark) symbol above [GRAPH] key, you can press it to find out what page you're on.

### Tech Tips

- This activity includes screen captures taken using jsTIfied, a calculator emulator that runs in your browser (http://cemete.ch/emu)
- This lesson applies only to the TI-84 Plus C Silver Edition.

### Lesson Files

- Student Activity: Zombie_Apocalypse_Pt1_Student.pdf
- Teacher Notes: Zombie_Apocalypse_Pt1_Teacher.pdf (this document)
- ZOMBIEA1.8xp and ZA1TD.8xv: Activity program files. Must be sent to handheld's Archive.
- Doors CSE 8.1, which provides necessary extra program functionality. *(Not included: download at http://dcs.cemetech.net).*

# Zombie Apocalypse Part I

## Send files to your TI-84 Plus C Silver Edition

Using TI-Connect 4.0 or higher, or a TI-84 Plus C Silver Edition calculator that already has this activity, send the program ZOMBIEA1 (ZOMBIEA1.8xp) and the AppVar ZA1TD (ZA1TD.8xv) to your TI-84 Plus C Silver Edition. Both files should go to your calculator's Archive.

- **Using TI-Connect:** Open TI DeviceExplorer and select your calculator. Drag ZOMBIEA1.8xp into the item labeled "Flash/Archive" and wait for the transfer to complete. Drag ZA1TD.8xv into "Flash/Archive" as well.
- **From another calculator:** Put the receiving calculator in Receive mode by pressing [2nd][XTθn][▶][ENTER]. On the sending calculator, go to the `Link` menu with [2nd][XTθn], choose `2: All-`…, then find "`ZOMBIEA1 PRGM`" and "`ZA1TD AVAR`" and press [ENTER] next to each one. Each one should be marked with a square, indicating that it will be sent. Press [▶][ENTER] to send the files over.

You will also need Doors CSE 8.1 or higher, which can be found at http://dcs.cemetech.net. The process of sending Doors CSE to your calculator is the same as above, and is also detailed in the Doors CSE readme document.

## Background

There are highly stylized images of zombies in this file. If you have students who have concerns with this activity, you may choose to skip past the pages with the zombie images. 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.

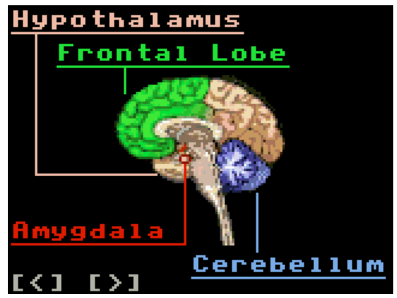
It is likely that students will question the mechanism of transmission. This activity depicts the zombie virus being transmitted through airborne saliva droplets from coughing and/or sneezing. Movies and television programs have treated the zombie "infection" in different ways. Students will ask if zombies 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.

# Zombie Apocalypse Part I

## Run the ZOMBIEA1 program; move to pages 2-6


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 that the virus affects:
   - **The Cerebellum:** Balance and Coordination
   - **The Hypothalamus:** Appetite
   - **The Frontal Lobe:** Intelligence and Problem Solving
   - **The Amygdala:** Anger and Rage

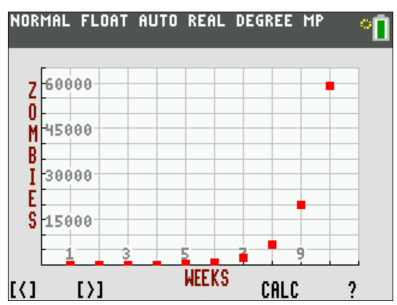
   The resulting symptoms:
   - **Affected Cerebellum:** Zombies clumsily shuffle forward.
   - **Affected Hypothalamus:** Zombies have insatiable appetites.
   - **Affected Frontal Lobe:** Zombies are poor problem solvers.
   - **Affected Amygdala:** Zombies aren't nice. They are full of rage.





2. After students review the parts of the brain on page 4, ask students: Can you think of some real diseases that affect the brain? Sample answers: Multiple Sclerosis, Parkinson's disease, Alzheimers disease, Epilepsy.
3. Pages 6 to 10 show the progression of the "zombie virus" as it affects the brains of its victims.

## Move to pages 11-12




4. Page 8 graphs the spread of the infection in the first months after the onset of the disease. Notice this graph appears to have an exponential pattern. For the curious students (and teachers), this graph has the following exponential function:

   $Z_n = Z_0(1+v)^n$ *where*

   $Z_n$ = Zombies after n weeks
   $Z_0$ = Initial infected zombies
   v = Virulence

   These graphs use virulence v=2 and $Z_0$=1.

# Zombie Apocalypse Part I

5. For discussion, ask students:
   - *What predictions can you make based on this data?*
     **Sample answers: It appears that after week 7, 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.**

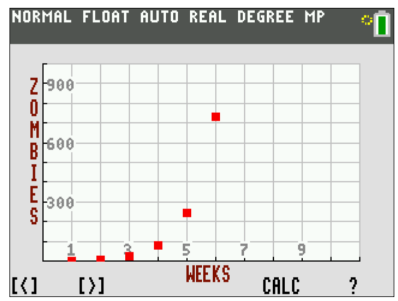
**Move to pages 13-21. Answer the following questions here, in the space provided.**

Q1. The greatest rate of infection occurred between week _____ and week _____.

**Answer: Between week 9 and week 10**

Q2. (a) What is the approximate infection rate between week 1 and week 6?

**Answer: Relatively low; the graph makes it looks like zero.**




(b) Now read page 15 and use the graph on page 16, which zooms in on the early part of the graph on page 12. What is the approximate infection rate between week 1 and week 6?

**Answer: By inspection: The points look like (1,0) and (6,720) or so. The students should realize that rate = quantity/interval, so the average growth rate is approximately (720 – 0)/(6-1) = 720/5 = 144 zombies per week.**

Q3. Take a look at the graph on page 19 and 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. Some students might point out that there may not be enough new humans to infect to maintain this trend. From the equation on the previous page, the exact answer is $Z_{25} = Z_0(1+v)^{25}$ for v=2 and $Z_0$=1, so $Z_{25} = 3^{25} = 8.473 \times 10^{11}$ (847 billion).**

Q4. Explain what will happen 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.**

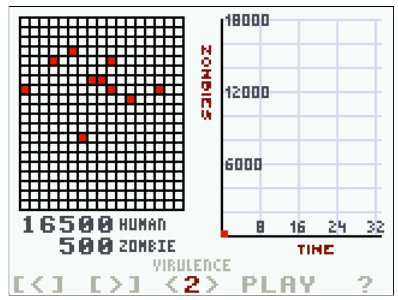
**Move to page 22.**

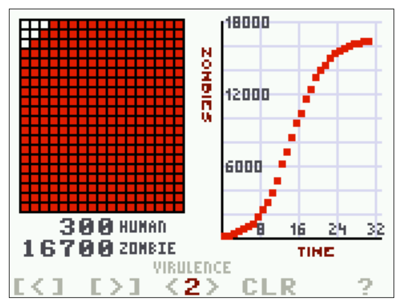
6. The rate of infection of any disease will eventually decrease because of many different factors. For this activity, the main factors are lack of food (healthy humans) and lack of additional targets to infect (again, healthy humans). For other epidemics or diseases those factors may include the development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

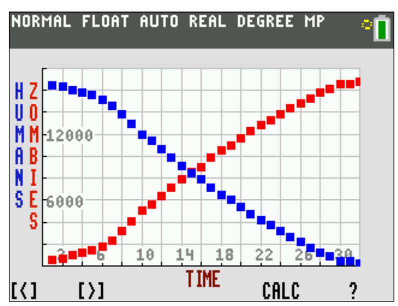
**Move to pages 23-25.**

7. Pages 23 to 25 introduce students to the idea that the zombification rate is limited by certain factors such as 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 alongside the simulation. The following page, page 25, shows the inverse relationship between humans and zombies as the disease progresses through the population. 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 low susceptibility).

   ***NOTE:*** *The last two pages of the teacher notes include sample screen shots for virulences from 1 through 9. Use these for comparison purposes. Since the simulation is probabilistic (as the spread of a virus would be in the real world), your results will not look exactly like these graphs. 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 should use 9, and then some between 1 and 9. Have them compare and contrast their different graphs on pages 24 and 25 of the activity.*

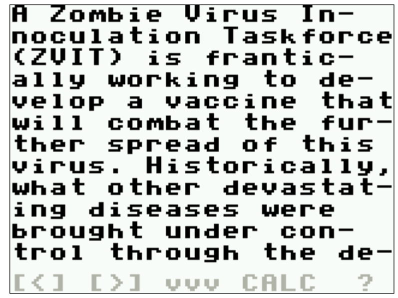


# Zombie Apocalypse Part I

**Move to pages 26-34. Answer the following questions here, in the space provided.**




Students will answer questions 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 pages 33-34 to wrap-up the activity with a discussion on diseases and vaccines that are real, and relevant to students.

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 2, the numbers of each would be equal near 15 weeks. (answers may vary)**

Q7. Based on the graph of humans and zombies from the previous page, 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!**

# Zombie Apocalypse Part I

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

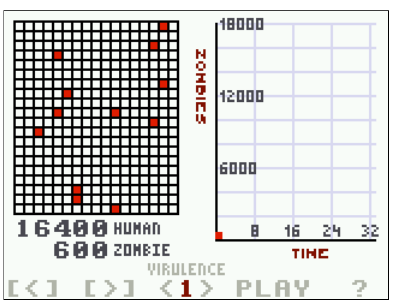
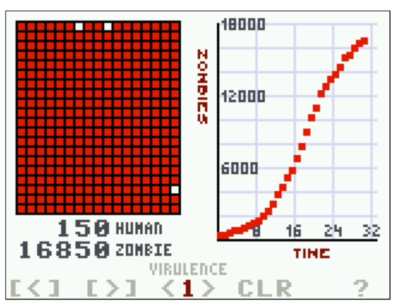
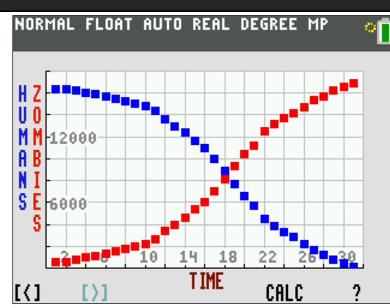
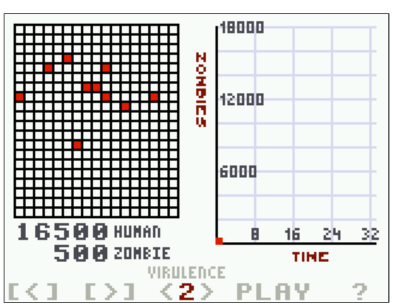
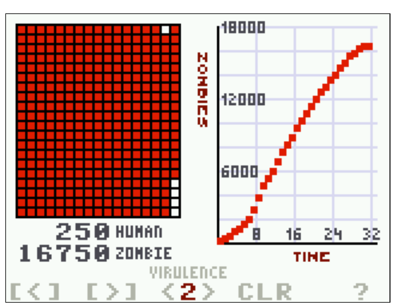
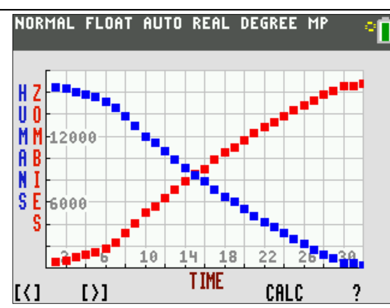
Students will have various results depending upon the virulence setting they used. Have students compare their graphs and discuss why the results are different.

## Assessment

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

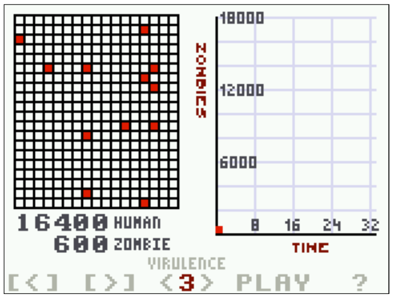
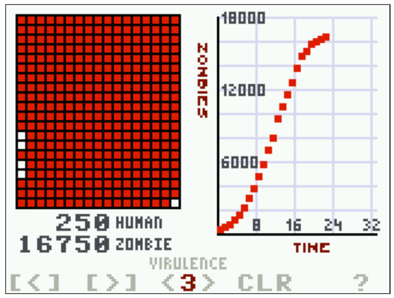
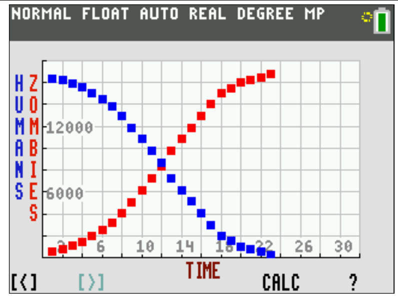
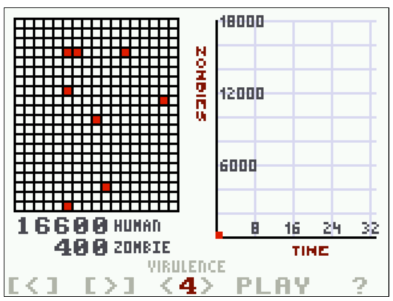
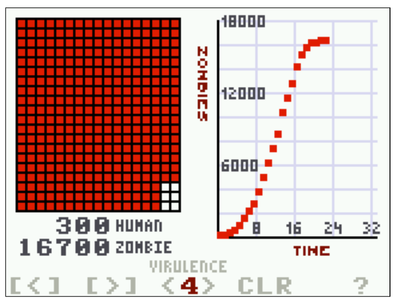
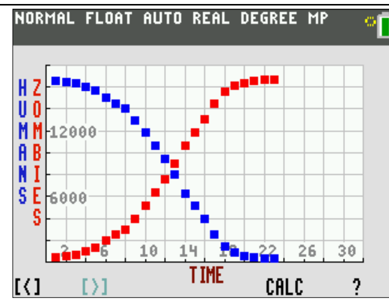
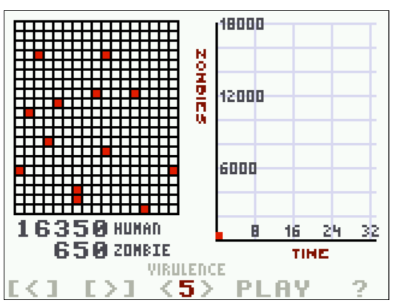
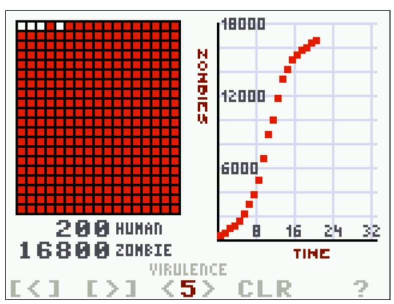
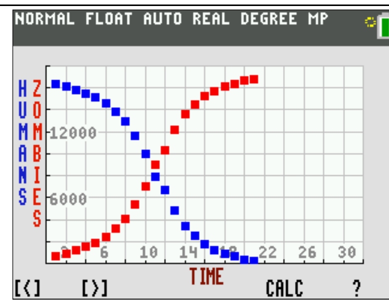
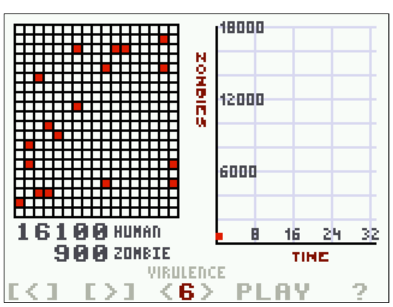
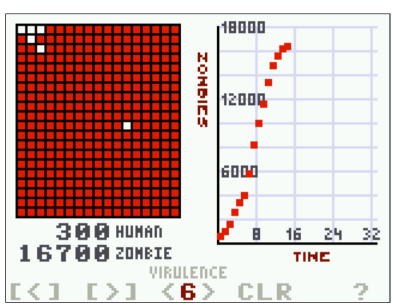
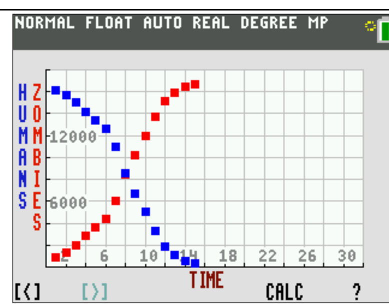
The next three pages contain sample screen shots for virulences from 1 through 9. Use these for comparison purposes.

**Sample Data** – Screenshots with different virulence (1-2)

| Start Simulation | End Simulation | Humans vs. Zombies *(Point of intersection found by inspection)* |
|---|---|---|
|  |  |  Intersect = (18.5, 8500) |
|  |  |  Intersect = (15, 8500) |

# Zombie Apocalypse Part I

**Sample Data** – Screenshots with different virulence (3-6)

| Start Simulation | End Simulation | Humans vs. Zombies *(Point of intersection found by inspection)* |
|---|---|---|
|   |   |  Intersect = (12, 8500) |
|   |   |  Intersect = (12.5, 8500) |
|   |   |  Intersect = (10.5, 8500) |
|   |   |  Intersect = (8, 8500) |

# Zombie Apocalypse Part I

**Sample Data** – Screenshots with different virulence (7-9)

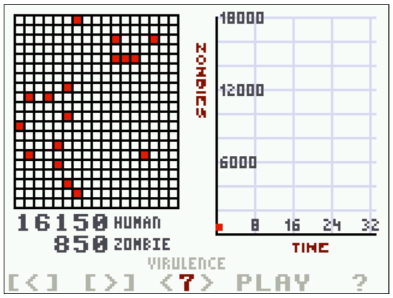
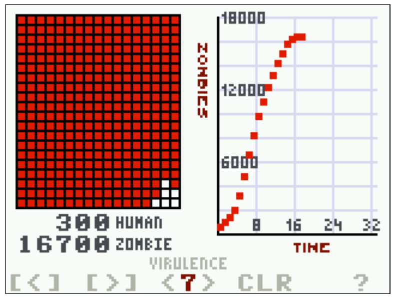
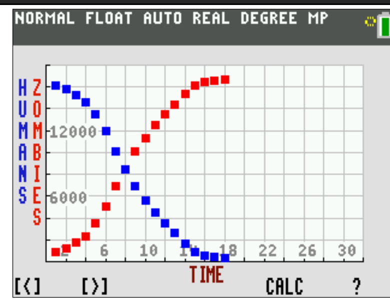
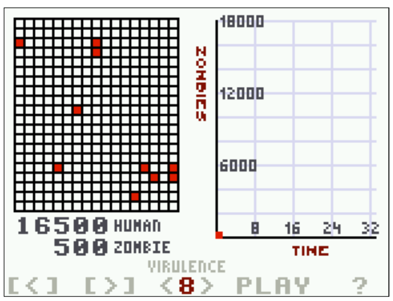
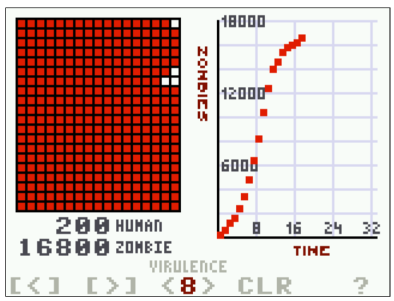
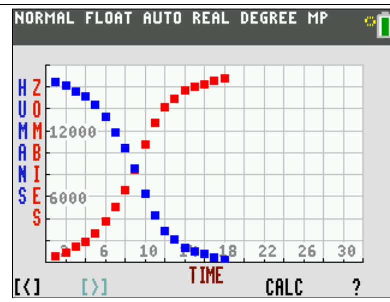
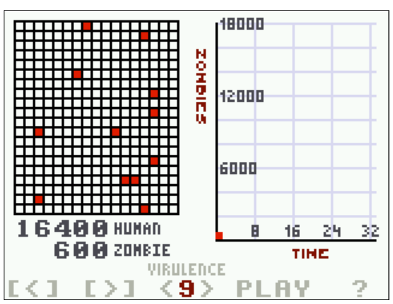
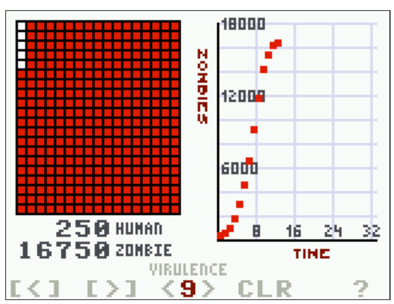
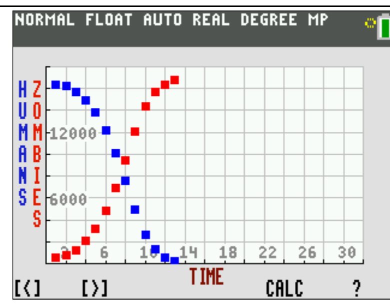
| Start Simulation | End Simulation | Humans vs. Zombies *(Point of intersection found by inspection)* |
|---|---|---|
|  |  |  Intersect = (8, 8500) |
|  |  |  Intersect = (9, 8500) |
|  |  |  Intersect = (7.5, 8500) |

Image Credits: Adapted from work by Texas Instruments. See readme.txt for full links.