Lesson Plan: Exploring Models to Show the Spread of a Disease

**Learning Objectives:**

1. Students will be able to identify and describe strengths and limitations of models.
2. Students will be able to describe how vaccinations benefit group immunity to a disease.
3. Students will be able to identify ways in which the spread of a disease is a complex system.

**Introduction:**

This lesson will occur sometime after students have received background knowledge on models and complex systems. Students will be told to follow their instructions in order to answer this main question:

What percentage of a population needs to be vaccinated in order for the population to have immunity (herd immunity) to a particular disease?

Students will also be told to think about the aspects of the model that are true, and which pieces of reality are missing from the model related to transmission of a disease.

Next, students will be told to consider parts of the code that reveal “rules” that are followed in the transmission of disease that make it a complex system, reminding them of this characteristic of a complex system”

Complex systems are composed of multiple interacting parts, or agents, whose interactions give rise to the outcomes of the system. The agents are not "trying to" create the high-level system outcomes. Rather, the outcomes "emerge" as a result of interactions at the level of the agents..

Lastly, students will be encouraged to play around with the sliders and ask other questions following the main parts of the lab!

**Worksheet for the lab:**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_

**Exploring Models:**

**Spread of a Disease**

Open today’s Schoology page and click on the link provided to open StarLogo (or click on this link: [https://www.slnova.org/vmetz!/projects/754312/](https://www.slnova.org/vmetz%21/projects/754312/)). Press “Edit Camera” to zoom in by scrolling. Press “Lock Camera” When you are happy with your view and can see the whole square.

 **\*Guiding Procedure**: Setup the simulation to run with a population of 100. There will always be 1 infected individual for the questions you are answering, so keep that to 1 (1% of the population infected)! So, if you start with 99 “unvaccinated healthy individuals,” you will have 0 “vaccinated individuals.” If you start with 98 “unvaccinated healthy individuals,” then you will have 1 “vaccinated individual,” and 1 “infected individual.” Press “Setup” and Press “Forever” when you are ready to begin!

The main question you will answer today is what percentage of the population must be vaccinated in order for the whole population to have immunity to the disease (all become blue)?

1. Before we answer that, though, I would like you to assume there are no vaccinated individuals (was the case with the CoronaVirus). Press pause (upper right) or press “forever” to pause it once there are no infected individuals (red). Take a screenshot of the graph. How many people died in this case? \_\_\_ What percentage of the population died in this case? (previous answer/100) \_\_\_

2. Run the simulation again with the same starting point as above. Be sure it is set at a slow speed (2-5). What are some things you notice about the transmission of the disease? (do all yellow spheres that make contact with red spheres turn red?)

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3. Some red spheres turn blue over time. What do you think this represents?

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Complex systems are composed of multiple interacting parts, or agents, whose interactions give rise to the outcomes of the system. The agents are not "trying to" create the high-level system outcomes. Rather, the outcomes "emerge" as a result of interactions at the level of the agents..

4. What are some patterns you see that result from “rules” that are followed by the agents (red, yellow, or blue)?

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Next, answer the main question using the “Guiding Procedure” section on this sheet if you forget how to set up the toggles to test this!

**5. What percentage of the population must be vaccinated in order for the whole population to have immunity to the disease (all become blue)?** Remember to press setup every time you change the toggles to “reset.” (# of vaccinated individuals becomes the percent since it’s out of 100)!

 \_\_\_\_\_\_\_\_ % of the population must be vaccinated in order for the whole community to have immunity to the disease.

6. Do you think this is higher or lower than in reality?

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7. What are the challenges getting this percentage of a population vaccinated?

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8. The population of Lansdale is 16707. How many people would need to be vaccinated in Lansdale for everyone to be immune? (16707 x (% found in #5/100) \_\_\_\_\_\_\_\_\_\_

9. Change the population of healthy, unvaccinated individuals to 75, vaccinated individuals to 0 and keep infected individuals at 1. Take a screenshot once there are no red remaining. How many individuals died in this case? \_\_\_\_

10. What is the percentage of the population that died (# who died/75 \*100) = \_\_\_%

11. Does this compare to the percentage who died in #1. Is this true of less populated areas (rural) vs more populated areas (cities) and disease transmission? If so, explain how it is similar. If not, explain some limitations of this model that make this different from reality.

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**Concluding Questions:**

12. Explain some aspects of disease outcomes that result from patterns or “rules followed” at the level of the agent (individuals or disease). What are some “rules” you noticed being followed by agents? (refer back to #4 if you are stuck)

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13. What are some limitations of this model (things that are not true of the reality of disease transmission? How could this model be made to better reflect reality?

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14. What are 1-2 strengths of this model (things that are pretty accurate when compared to the reality of disease spreading in a population).

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**Experiment Time!!**

15. Ask your own question that can be tested using this simulation (try to only change one variable), write out your prediction (what you think you will happen when you adjust one variable), and your results (what actually happened). Feel free to insert a screenshot!

Question: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Prediction:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Results/Conclusion: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Conclusion/Discussion:**

Following the lab, I will call on students to share their answers and have a classroom discussion of their answers to the main questions:

1. What are some “rules followed’ by the agents- the individuals or the disease that shows patterns at a larger level, indicating that the spread of a disease is a complex system? (look at #12 if you’re not sure what I’m asking)?
2. This model is one that I made so there are MANY problems, but there are also some important patterns present, reflecting reality. Share with a partner what you saw as strengths and limitations of this model. (wait 3 min). Now, who would like to share something *your partner* said?
3. Now, what percent of the population (of 100) needed to be vaccinated to result in complete immunity to a disease (all turning blue)?

Do you think this reflects reality? (I had to turn mine to 99% vaccinated. Reality is about 70-90). Why is our percentage higher than reality? (Probably because we only had a population of 100. We could, for example, decrease the size of the spheres, increase population to 1000, increase number of infected individuals to 10 (still 1%), and see how this changes % vaccinated).

I would also point out that as percent vaccinated individuals increase, death rate decreases and the rate at which there are no infected individuals increases!

This would be a good time though to talk about challenges associated with getting people vaccinated.

1. Lastly, I will ask students to share some of the questions, predictions, and results they saw!!