RESET | Pesticide Resistance

AN AEOP EFFORT aeop

TEACHER

Facilitator: Tracy Davis

Barbara Waters &

Carey Wilson

SUBJECT/GRADE LEVEL

Subjects: Biology 1, Environmental Science, Algebra 1

Grade Level: High School

Materials (In Person)

- Set up the Exploration Lab (pp. 3, 5-7)
- Familiarize yourself with and set up Desmos Activities for your class(es).
- Upload hyperdoc to Google Classroom, and use it as a guide throughout the lesson.
- Set up the Exploration Lab (pp. 3, 5-7)

Materials (Virtual)

- Check all hyperdoc links to make sure they all work!
- Familiarize yourself with and set up Desmos Activities for your class(es).
- Upload hyperdoc to Google Classroom.

STANDARDS

Next Generation Science Standards

- HS.L.S4.2: Biological Evolution: Unity and Change: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

Mathematics Standards | Common Core State Standards

- CCSS.MATH.CONTENT.HSF.LE.A.1: Distinguish between situations that can be modeled with linear functions and with exponential functions.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.ESL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

LESSON OBJECTIVE(S)

Biology: Students will use mathematical models as evidence to construct an explanation for the process of evolution.

Math: Students will discuss graphs that depict the rate of resistance for bugs to determine how the data might best be mathematically modeled.

CAREER CONNECTION(S)

Mentor Background: **Entomologist Team -**
Rosanne (Anne) Radavich - Entomologist Chief, Product Development and Education Branch
Jessica Mathios - Entomologist Project Officer, Product Development and Education Branch
Jennifer Carder - Entomologist Chief, Pesticide Use and Resistance Monitoring Branch

Description - The Entomological Sciences Division (ESD) is charged with overseeing safe pest management across the Army, and protecting personnel from insect- and arthropod-borne diseases (Lyme disease, Zika virus, West Nile virus, dengue, malaria, and many others.) ESD works to ensure safe and effective pesticide use by reviewing, analyzing, and archiving pesticide application records, and runs a Department of Defense pesticide hotline to provide world-wide guidance and assistance. The Division recently began work to characterize pesticide resistance levels in mosquitoes capable of transmitting diseases on Army installations. This new mission involves collecting, identifying, and raising mosquitoes for Centers for Disease Control and Prevention bottle bioassays and molecular assays to detect pesticide resistance. In addition to pesticides work, ESD develops information products and training for public health personnel and conducts STEM outreach to support the local community. As part of these efforts, the lab rears mosquitoes, cockroaches, and 20 different species of food-infesting insects that impact the Department of Defense. The mosquitoes are used for both outreach/education, and as positive controls for the pesticide resistance bottle bioassays. The food-infesting insects are used to teach military food inspectors and public health personnel how to recognize, prevent, and manage infestations in food. Some of these insects can cause health issues (respiratory, digestive, and dermal problems, or tumor formation), while others degrade food quality and are bad for morale. We also maintain a colony of Madagascar hissing cockroaches for teaching and outreach. These roaches are big, slow, and harmless, so they are excellent tools to teach insect anatomy and behavior, and make great, low-maintenance classroom pets. (Meadows, 2020, s. 13)

Local Background: **Pesticides Managers (Locally)**

It might be great to link this lesson plan to other classes at your school such as a CTE class, where students might already be learning about pesticides already. Also, an Agricultural Extension Agent might be a great person to contact to ask to introduce this topic to your classroom as well.

STEM Careers: Researcher (University of Tennessee), Pesticide Managers (Career Technical Classes).

ENGAGEMENT

Classroom	Virtual
Teacher Actions: If you have a speaker to introduce this topic, have them talk first. When the students have had the opportunity to listen and ask questions of the expert, you could ask them the following question: When do you think the highest mortality rate occurs when pesticides are applied to an area? **Student Actions:** Students will work in groups to discuss the answer to this question. After discussing in small groups, you could discuss further in a large group or move on to *Exploration*. It would depend on the large group discussion.	**Teacher Actions:** Upload HyperDoc to GoogleClassroom or your online classroom and have students work through the HyperDoc to complete their work. **Student Actions:** To complete this virtual lesson, students will access the following HyperDoc. watch the introduction video, follow the first link to share their thoughts about this introduction, write in their answer in the right column, and progress through the hyperdoc.

EXPLORATION

Classroom	Virtual
Teacher Actions: Set up the activity under the "Exploration" tab on the "Persistant Pests" lesson here (Agsploration, The Science of Maryland Agriculture, n. d.). **Student Actions:** Students will complete the activity that models pesticide resistance and natural selection. See link above.	**Teacher Actions:** Share the article about the Colorado potato beetle here (pdf) (Also in the HyperDoc) **Student Actions:** Read the article about the Colorado Potato Beetle in the link above.

EXPLANATION

Classroom	Virtual
Teacher Actions: In the classroom, have the slides printed on notecard size paper to give to student groups (preferably groups of two) to discuss. You might also want to project the questions asked for this section of the lesson. At the end of a given time limit (15-20 minutes), ask students to share. **Student Actions:** Students work in groups to examine the graphs and answer the following questions. 1. What general trends do you notice about each graph on each slide? 2. What do you notice about each line representing different bug sprays on each slide? Slide 2 - Slide 3 - Slide 4 - 3. Which spray works the fastest? 4. Which spray kills the most bugs? 5. Which spray is the most effective and why? 6. Which spray is the least effective and why? 7. When do you think the highest mortality rate occurs when pesticides are applied to a given area and why? At the end of the time, a student will share the group's discussion (preferably not the one who did all of the writing).	**Teacher Actions:** Have students look at the following slideshows of different Rate of Resistance graphs. These graphs depict the mortality rate of insects over time given different pesticides or different doses of pesticides.. **Student Actions:** Students will answer the following questions in the right column. 1. What general trends do you notice about each graph on each slide? 2. What do you notice about each line representing different bug sprays on each slide? Slide 2 - Slide 3 - Slide 4 - 3. Which spray works the fastest? 4. Which spray kills the most bugs? 5. Which spray is the most effective and why? 6. Which spray is the least effective and why? 7. When do you think the highest mortality rate occurs when pesticides are applied to a given area and why?

ELABORATION

Classroom	Virtual
Teacher Actions: In the classroom, have the videos (Video 1, Video 2, and Video 3). Then have each person log into a computer/Chromebook and complete the Desmos activities (Desmos activity 1 and Desmos activity 2). Once done with the Desmos activity, students should create a Google Doc, respond to each question (given below), and submit their documents. **Student Actions:** Students work by themselves to interact with the Desmos activities and answer the questions stated below. 1. Identify which model (linear or exponential) might better fit the rate of resistance graphs? 2. Explain why you have selected the mathematical function in great detail. At the end of the time, each student will turn in their answers recorded in Google Docs.	**Teacher Actions:** Have students 1. Watch the videos (HyperDoc), 2. Do the Desmos activity (HyperDoc), and 3. Create a Google Doc to share which mathematical model they have selected and why. **Student Actions:** Students will: 1. Watch these videos about linear and exponential functions.. Pay close attention to the general appearance of the graph. 2. Complete the Desmos activity online. Be sure to answer each question posed to you in the Desmos Activity (part of your grade). Pay close attention to how the data is related to the outcome/appearance of the graph. 3. In a separate document: a. Identify which model (linear or exponential) might better fit the rate of resistance graphs? b. Explain why you have selected the mathematical function in great detail.

EVALUATION

Classroom	Virtual
Teacher Actions: Model how students may use Desmos graphing calculator to find the "line of best fit" for their data collected from the exploration (directions) **Student Actions:** Students will model their data by following the data in class. Afterward, they will decide how to answer the following questions based on their unique results. Additionally, students will: 1. Hyperlink their completed Google Doc (with a Screenshot of the Final Desmos regression/mathematical model they chose as the best fit for their data). 2. They will answer the following questions as well. a. Does your selected model support your model selection from the "Elaborate" part of this lesson plan? Why do you think your answer was right (OR) Why do you think your answer was wrong? b. What questions do you still have? Please include your questions in this document. i. If you chose a linear model, where else do you think linear models might be useful to mathematically express a different real-world situation? Please be detailed in your answer.	**Teacher Actions:** Have students model their data on Desmos to determine if their selected model in *Elaboration* works for their data. **Student Actions:** Students will: 3. Hyperlink their completed Google Doc (with Screenshot of Final Desmos regression/mathematical model they chose as the best fit for their data). 4. They will answer the following questions as well. a. Does your selected model support your model selection from the "Elaborate" part of this lesson plan? Why do you think your answer was right (OR) Why do you think your answer was wrong? b. What questions do you still have? Please include your questions in this document. i. If you chose a linear model, where else do you think linear models might be useful to mathematically express a different real-world situation? Please be detailed in your answer. ii. B. If you chose a linear model, where else do you think linear models might be useful to mathematically express a different

ii. B. If you chose a linear model, where else do you think linear models might be useful to mathematically express a different real-world situation? Please be detailed in your answer.	real-world situation? Please be detailed in your answer.

Possible - EXTENSION

Classroom	Virtual
Teacher Actions: Inquire into local sources for pesticide use in our area. Ask additional experts to come and talk in class, and/or have students do further research about pesticides on their own. **Student Actions:** Students might benefit from doing research on pesticide use in their English classes.	**Teacher Actions:** Inquire into local sources for pesticide use in our area. Ask additional experts to come and talk over Zoom, and/or have students do further research about pesticides on their own. **Student Actions:** Students might benefit from doing research on pesticide use in their English classes.

REFERENCES

- Agsploration, The Science of Maryland Agriculture. (n. d.). *Persistent Pests* [Lab directions]. University of Maryland. Retrieved from https://extension.umd.edu/sites/extension.umd.edu/files/_docs/programs/agsploration/Lessons_edition3/19%20Persistent%20Pests.pdf
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