Lesson 4: "Why Do Some Variations Become More Common and Others Disappear?" (part 2)

Overview:

Purpose:

The purpose of this activity is to have students engage in simulated natural selection to discover how natural selection emerges from mechanisms: a) variation in heritable traits in a population and b) interactions in the environment give individuals with some variations a competitive advantage over other individuals. Another purpose is compare these mechanisms to those of intentional selection and random selection in selective breeding and describe the outcome of natural selection as an increase in the proportion of individuals with advantageous heritable trait variations in a population over multiple generations.. .

Performance Expectation

- *Design and conduct an experiment to provide evidence to explain* why organisms with different kinds of heritable traits tend to increase in proportion to organisms lacking this trait in different environment with no predators. **NGSS HS-LS4-3. [**Emphasis is on analyzing shifts in numerical distribution of traits in a histogram and using these shifts as evidence to support explanations.]

Scientific Principles Discovered in this Activity

- Revise this previous principle (**bold** is newly added): As a result of natural selection, distribution of traits in a population can change when interactions in the ecosystem change **or environmental conditions change, this tends to lead to organisms that are well suited for survival in particular environments.**

Description of the Lesson

The teacher first introduces the new model. Students then design an experiment to explore how different distribution of food/water in an ecosystem and different metabolisms for different behaviors (due to a physical trait – flagella number) affect the outcomes of natural selection in population of virtual bacteria.

Students present their initial results to the class and the class discusses possible explanations for why these different conditions yield different shifts in the distribution of trait variations from natural selection.

Groups return to their experimentation and develop their explanations further, and report these out at the end of their experimentation.

At the end of class, the teacher develops class consensus on the big ideas regarding the conditions necessary for natural selection and revises the scientific principle from the last lesson.

Lesson Details:

Time 90 min.

Materials

Per Student

- 1 computer with Java 7 and Firefox installed.
- A student WISE account for the class period was already created.
- One small post-it note and one large post-it note.

For Teacher

- 1 computer with Java 7 and Firefox installed and projector or large display screen for the teacher to display the computer model.
- The case study board and the driving question board
- 1 piece of butcher paper or poster paper or space on the wall for students to stick the post it notes on.

Lesson Outline and Timing

Launch

- Introduce today's question and students login to WISE, waiting to answer step 4.1 (3 min.)
- Play Screencast of the model, pausing the movie at one point for students to make predictions (5 min.)
- Discuss experimental possibilities with a partner (2 min.) (step 4.4)

Experiment with a partner

- Conduct experimental runs on 1 or 2 computers per partnership (step 4.5-4.7) (15 min.)
- Pause and report out some initial findings (10 min)
- Return to experimentation (15 min).

Summarize

- Present results and respond to presentation of other students (step 4.8) (20 to 25 min.)
- Summarize discoveries from presentations and lead a Consensus Building Discussion to revise an old scientific principle about natural selection (10-15 min.)

Lesson Enactment Details

Launch:

Remind students of the discoveries they made related to their driving question pointing to and reviewing the ideas captured on the driving question board. Tell students that they will continue exploring the same lesson question as yesterday, "How Does Nature Select For Some Trait Variations Over Others?"

Tell students that they are going to be designing some of their own experiments with natural selection by adjusting the distribution of food and water resources in different environments, testing these conditions, and reporting out their outcomes to their classmates. Tell students they will use a model that is similar to the one they used last time (with bacteria and flagella), but this time there will be no predators in the model.

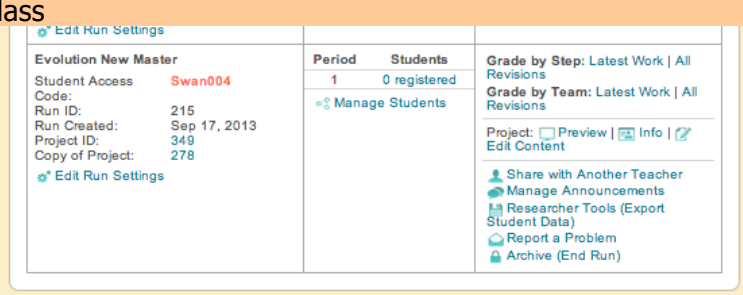
- **Have students log into WISE and go to step 4.1**

Next, demonstrate how this model works using the Screencast of the model.

Demonstrating the model via. Screencast

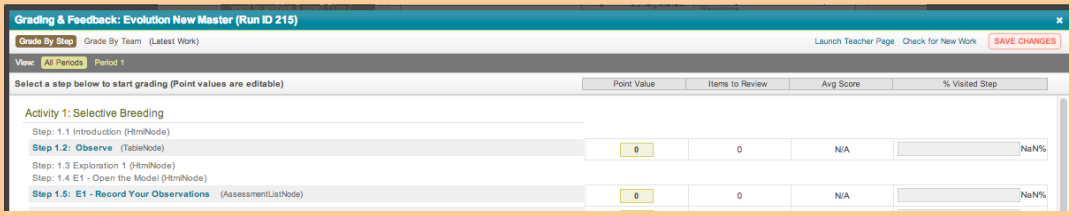
Model Demonstration Directions For the Teacher

1. You too will want to log into WISE in teacher mode, but will launch the same model the students will be using in later steps. Click on the Teacher Home tab. You will see a list of all the active runs you have started for each class period. For the current class that you are teaching. In the example below, the first row show the Student Activity for this Teacher's Period 1 class

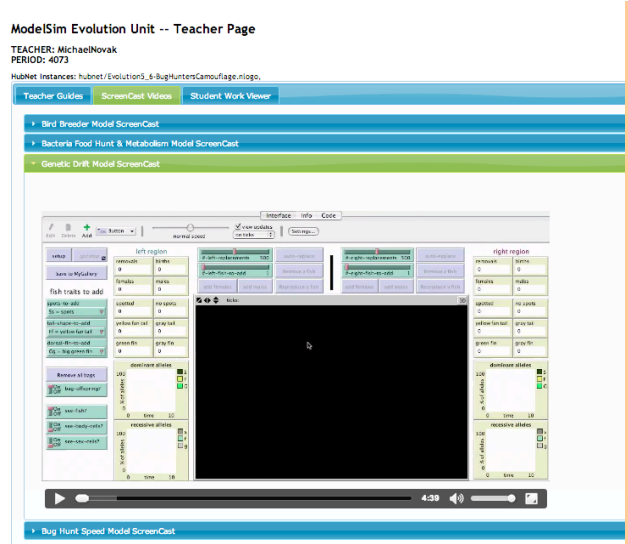


2. Look for the Grading & Tools Column to the right. Under that look for the Grade by Step heading and click on the Latest Work link.

3. The teacher Grading & Feedback page will come up. Click on Launch Teacher Page on the top right of the page.



4. Click on the Screencast Videos tab. Click on the Bacteria Hunt Food & Metabolism Link.



5. **Make sure students are on step 4.1** and tell them that when you play the video you will need them to record some information about how the model works and make a prediction. You will now play the first 1:00 minutes of a screencast of a sample model run, and then will pause the video.

6. Press the play button. Audio narration is provided. Pause the video at 1:00, **have students complete step 4.1 and 4.2 at this point.**

7. Press the play button to resume the video, **have students complete step 4.3 at the end of the Screencast.**

- **Have students go to step 4.4** and discuss some possibilities to investigate in an experiment (step 4.4). Tell students that they may conduct their experimental runs on 1 computer together, or use both of their computers to test and compare multiple trials.

Explore

- **After partners have discussed some possible experimental designs, have students complete Steps 4.5 through 4.7**

- Pause students after about 10 to 15 min. of exploration and have groups briefly report out any interesting initial findings. Ask groups if they tested those conditions many times to see if they always get the same results exactly, or generally the same results, or if there is lots of variation in the results they are getting. Some classes sometimes decide to change the direction of their experiment at this point… example: the class thinks we should all test a particular set of conditions, …example: the class thinks we should all test our own experiments a dozen times…example: the class thinks we should split up the "experimental behavior space" that we explore, and assign each group to look at a particular combination of environmental conditions).

- Resume investigations for another 15 minutes.

Summarize:

Allow 20 to 25 minutes to have student volunteers present their results in a short 2-3 min. summary from the class gallery, showing their image from the gallery to the class and explaining why they got the outcomes they did in the different regions. Ask audience members to volunteer these sorts of responses:

- Questions that would help clarify your understanding of the argument being.
- Similarities or differences between the evidence presented by different people.
- Insights into discoveries the class is making about the lesson question, "How does natural selection change population in different environmental conditions?"

- **These comments can be posted on step 4.8 (optional) . But also having students share these verbally can help strengthen the discussion dynamics in a class**.
- **After volunteers have presented, have students bring a post it note or index card up to summarize a big idea discovered after they record it in step 4.9.**

As a teacher, ask every group that presents, what is it that is causing the distribution of traits in the population to shift toward one kind of variation over others? Why is that variation advantageous over ones that cause the bacteria to move slower, or faster, or both?

For the summary of big ideas from the presentations, review the ideas from the last lesson (shown in yellow). Modify the scientific principle to include environmental changes. Ask the students for examples of environmental changes besides only where the water or where the food is located in an ecosystem.

Have students bring the papers/post-its to a board so that it is displayed for the class to look at together. Lead a consensus building discussion around that board. Facilitate the movement and reorganization/clustering of the ideas students brought up, under the headings listed below. This consensus building discussion and reorganization of the student descriptions of their discoveries will help students condense and summarize the big ideas from the day's lesson. If an idea that students suggest doesn't fit under these areas, don't leave it out. Rather, emphasize that the idea shared is another interesting discovery and that the main ideas that the students are responsible for knowing and reusing in future explorations are the ones organized under the areas listed. Try to write the categories in the student's own words, and using their own papers if possible. You may want to consider posting these big ideas in class, having students summarize these ideas now (or later) in their notes. Either way, try to use the students own words and the way the class expresses the ideas listed below, without feeling it is necessary to use this exact wording. Examples of possible student responses they might contribute on their sheet or post it note are shown in italics. Ask students whether they agree or disagree with how the ideas or organized and whether this summary helps pull out the main points they discovered.

The underlined statement is the suggested category. The non-bold italics statements are possible student ideas. The bold italics statement can serve as another way to summarize what is common amongst the student ideas and each underlined category.

Conclusions & Big Ideas: "Why Do Some Variations Become More Common and Others Disappear?" (part 3)

Natural selection occurs when:

- **There is variation in heritable traits.** *(in every species such variation exists).*
- **Some variations give a competitive advantage for survival**
- **The individuals with variations that do not grant a survival advantage die more frequently.** *The interactions between the environment & the population unintentionally kill off individuals with variation(s) of traits that give a competitive disadvantage for survival more often than the others.*
- **The surviving individuals reproduce.** *As a result the surviving individuals are more likely to*

reproduce (either asexually or sexually), and create more offspring.

Leads to different outcomes of natural selection:

- **When environments change (including other organisms that inhabit it change), the survival value of inherited characteristics may change.**
- **As a result of natural selection, the proportion of individuals in a population that have advantageous traits tend to increase over time after an environmental change; this tends to lead to organisms that are well suited for survival in particular environments.**

Revise this previous principle (**bold** is newly added):

- As a result of natural selection, distribution of traits in a population can change when interactions in the ecosystem change **or environmental conditions change, this tends to lead to organisms that are well suited for survival in particular environments.**

Homework Assigned: None