MOSA MACK SCIENCE

Adaptation and Selection Lesson 1: *The Solve*

Educator's Resource Guide: Live Video Phenomenon

The Solve contains two mini lessons: The live video lesson and the animation lesson. For the most comprehensive learning experience, conduct both. If you're short on time, choose one. Which lesson?

- For a more structured lesson, choose the animation
- For a more inquiry-based lesson, choose the live video lesson (the lesson below) and assign the animation for homework.

Objective

In *The Solve*, students will:

1. Observe phenomena and conduct investigations to explain what they observed.
2. Discover the driving forces behind natural selection and adaptation.

The Activity

Students will view two videos showing two iguanas that have adapted to different environments. They will make an educated guess as to why the iguanas look so different. They will then engage in an activity that may help them discover the answer. In the activity, they take on the role of a bird and eat as many moths as they can find. The moths are different colors, and some are easier to spot than others. Through this activity, students will determine that certain traits are advantageous in an environment. They will use this knowledge to revisit the iguana mystery, label images with scientific terms, and hone their initial explanation.

Phenomena Description

Videos of two different iguanas—a land iguana and a marine iguana—reveal that although both are iguanas, they have drastically divergent characteristics. Students will conduct investigations to determine which environmental factors may have caused these adaptations and will further investigate how natural selection has an impact on changes in the development of populations, such as those of moths.

Time Required: 80 minutes

Materials Required	

• Video clips
  ○ Marine Iguana and Land Iguana
• Student Guide
Materials for the Virtual Activity: Computer with access to the Mosa Mack *Live Solve* Link
Materials for In-Class Activity
• Computer with speakers (for projecting video) or headphones (for student viewing on laptops)
• Stopwatch
• Colored pencils or highlighters
• Adaptations Box (1/class)
  ○ One newspaper-lined box (with a cover/lid)*
  ○ Moth cutouts (template located in Appendix A)**
  ■ 20 newspaper moth cutouts
  ■ 20 red moth cutouts
  ■ 20 black moth cutouts
*Multiple box sizes will work. The most important thing is that the box has some type of lid so the students don't see the moths in the box before they're ready to select moths.
**It may be helpful to print and create extra moth cutouts in case any are torn during the activity.	

Safety Considerations	**Science & Engineering Practices**
None	• Using Mathematics and Computational Thinking • Constructing Explanations and Designing Solutions

Inquiry Scale: Leveling Information for in-class use

The Solve can be completed in various settings, including presentation-style, small groups, or individually.

Level 1: Most teacher-driven

View the video clip several times as a class. Discuss the video clip as a whole class. After the first viewing, prompt students with questions to lead them to more observations and invite them to ask questions about what they are seeing. Students will jot down observations in their Student Guide. If doing the activity in-class, model the moth activity in front of the class with a few volunteers, with all other students acting as observers. As a class, discuss the investigation and record observations.

Brainstorm together possible explanations based on observations in the videos and the moth activity, and complete the Student Guide as a class.

Level 2

View the video clip several times as a class. Discuss the video clip as a whole class. After the first viewing, students will work with their groups to jot down observations and questions in their Student Guide. Students will work in small groups on the moth activity, recording their observations as they investigate. As a class, discuss the investigation. Brainstorm together possible explanations based on observations in the videos and the moth activity and complete the Student Guide in small groups.

Level 3: Most student-driven

View the video clip as a class, in groups, or in pairs several times. Discuss the video clip as a whole class and then in student groups. Students will jot down observations and questions in their Student Guide. In their groups, students will do the moth activity and complete discussion questions in small groups. They will discuss the investigation in their groups and brainstorm possible explanations for the videos and the moth activity, but will complete the Student Guide individually.

Agenda

Part 1. Video Clips of Phenomenon: Iguanas in Action (5–10 minutes)

Differentiation Tip: The video can be viewed as a class, in small groups, or individually.

1. Students will view the two video clips of the iguanas. *These videos are exciting. Give students time to initially react before moving on to step 2.*

Information for the teacher only

(Do not share the following information with the students yet! You will be doing this in Part 3, question 2.)

Marine iguanas are unique among lizards worldwide as they are the only kind of lizard that primarily forages for food underwater. Surprisingly, these iguanas are herbivores, despite their menacing features. While foraging, their preferred food is algae. There are eleven subspecies of **marine iguanas** (five recently discovered) and all are native to the Galapagos Islands. Although they are able to move freely underwater, they are not as agile on land. Like other lizards, they are cold-blooded. The males soak up energy from the sun in the morning; upon entering the water, they slow their heart rate to conserve energy, which allows them to look for food for as long as possible. The oldest males typically forage underwater, while the females and young wait on land.

Marine iguanas are believed to have adapted their unique characteristics from mainland South American iguanas that floated out to sea on logs and eventually landed on the Galapagos Islands.

Like marine iguanas, **land iguanas** are herbivores, but land iguanas feed primarily on mustard greens, turnip leaves, flowers, and fruits that grow throughout Central and South America. Although land iguanas can swim, that is not how they forage for food. They have short, thick legs that give them great strength and allow them to move quickly.

2. Have students work in small groups to complete the Student Guide.

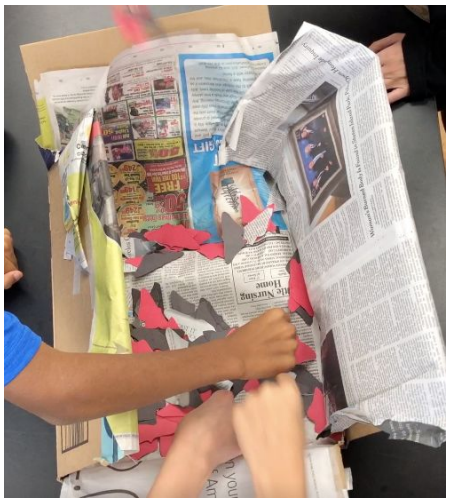
   Question 1: Watch both video clips of the iguanas. After watching the clips, make at least three observations about each type of iguana. Observations may include physical characteristics and behaviors. *Answers will vary. Possible answers may relate to skin color, size, and speed.*

   Question 2: Compare the iguanas. How are the iguanas similar? How are they different? *Answers will vary. Possible answers include:*
   Similarities: Both have scaly skin, both have a tail, both are short creatures.
   Differences: The land iguana has darker skin than the marine iguana; the marine iguana seems larger than the land iguana; the marine iguana seems to have pads on its hands whereas the land iguana does not.

   Question 3: How do you think it is possible for animals of the same species to develop so differently? Explain your thoughts. *Student answers will vary. Potential answers: Maybe the animals had different environments that caused them to be different; maybe they had different diets.*

3. Review answers with the students and transition them to Part 2 of *The Solve*. Introduce this section to the students.
   Share with students: You just drew some conclusions about the similarities and differences between iguanas. We have some outstanding questions, so we're going to do an activity to see if we can learn more about why animals look and behave the way they do in their specific environment. In your next activity, you'll be playing the role of a bird, and not just any bird—a hungry bird. Your job is to grab as many moths as possible in the time given to you.

Part 2. Let's Figure It Out! The Moth Activity (15–25 minutes)



Students will complete a mini-investigation to further explore natural selection and adaptation.

If students are doing this **virtually**, view instructions to Part 2 here

To Prepare

- Line a box with newspaper. Multiple box sizes will work, including 18" x 21.5" x 5.25", 17.75" x 14.25" x 8.25", and 17" x 13" x 8". The most important thing is that the box has some type of lid so the students don't see the moths in the box before they're ready to select them. The box lined with newspaper will act as a newspaper "habitat."
- Using the template in Appendix A, cut 20 moths out of newspaper (the same type of newspaper used to line the box), 20 moths out of red construction paper, and 20 moths out of black construction paper.
- Place all 60 moths inside the box.
- Place the box on a central table or on a table at the front of the room. *It is important that students do not see the moths in the box before they're ready to select moths.*

Directions

1. Introduce the activity to the students:

   We'll be doing an activity that represents a real-world example of the adaptations of moths. In small groups, you will act like birds collecting food (moths). When I call your group to the front, one of you will be the "box opener," and the other members will be "birds." When I say "go," the box opener will open the habitat, and the birds will have ten seconds to collect as many moths as possible using their pointer and middle fingers as a beak. You must keep your other hand behind your back while you collect the moths. You can only collect one moth at a time. After each group has had a turn, we will record the data in our class data table to be used later in graphing.
2. Organize students into groups of four, with three students as birds and one student as the box opener. (You can have one group of three or one group of five, if necessary, depending on your class numbers.)
3. Each team will come up with a team name, which they will record in the data table in their Student Guide.
4. Call the first team to the front after ensuring that the box is closed. When you say "go," the box opener will open the habitat, and the birds will have 10 seconds to collect as many moths as they can with their pointer and middle fingers acting like a beak.

5. At the end of 10 seconds, students will count and record the number of **eaten** moths (the moths taken out of the box) in their data table. Students will record the totals for their entire team. (Sample data is in Appendix B.)
6. Replace all eaten moths by putting them back in the box, making sure that there are 20 of each moth type.
7. Repeat for each group until all groups have had a turn.
8. After all groups have completed the challenge, have a representative from each group report the group's data to the teacher. Students record data for all groups in their data table. Sample data is located in Appendix B.
9. After all groups have participated, direct students to average each moth type by adding together the eaten moths for each color and dividing each total by the number of groups.
10. Give students time to document their experience in the Student Guide, including illustrations and detailed observations.
11. Graph the class results. Students can complete this individually, in groups, or as a class. See sample graph in Appendix B.
12. Students answer reflection questions about the moth activity in their Student Guide.

    Question 1: Using the class data gathered and evidence from your graph, which moth type was most easily seen in the given environment? *It is likely that the red moths were the easiest to see in the environment, but it is also possible that black moths were easily seen.*

    Question 2: From the moth's point of view, is the ability to be seen an advantage (known as an advantageous trait) or disadvantage (known as a disadvantageous trait)? Explain your reasoning. *The ability to be seen is disadvantageous because predators can find them easily. We can see this in the data when the moths that were easiest to see were the ones that were eaten.*

    Question 3: Which moth type is most likely to survive and reproduce over time? *The moths with the newspaper wings are the most likely to survive and reproduce over time.*

    Question 4: Given a similar newspaper environment, do you expect the newspaper-winged moth population to increase or decrease over time? *The newspaper-winged moth population will increase over time because they are the most likely to survive and reproduce.*

    Question 5: If the moths were on a red background, which moth population would be most likely to increase?

    It is most likely that the red moth population would increase as the red moths would be better camouflaged from predators if the background was also red.

    Question 6: Can an individual moth create a physical adaptation to fit into its environment, or do adaptations in moth populations evolve over time? Explain your answer. *Individuals cannot create physical adaptations to fit into their environment. For example, a red moth cannot will itself to be a newspaper-winged moth. Adaptations occur in moth populations over many generations. For example, one could say that having newspaper wings is an adaptation to the newspaper environment.*

13. As a class, review the questions and answers to ensure understanding.
14. Reveal to the students that this activity is based on a real-life example of what happened to moths during the Industrial Revolution. There are two natural variations of peppered moths: ones that have light-colored wings with black speckles and ones with black wings. Before the Industrial Revolution, moths with light wings were camouflaged against tree lichen, which was also light in color. Moths with dark wings were easily seen and eaten by predators, and their population declined as a result. During the Industrial Revolution, smog from factories polluted the air and darkened the lichen on trees. Ask students how the darkening of the lichen on the trees might have had an impact on what was previously an advantageous or disadvantageous trait.

    Answer: After the white lichen turned dark, the moths with dark wings were now the ones with an advantageous trait since their wing color camouflaged them in their dark environment.
15. In small groups, ask students to spend 2–3 minutes talking about animals with which they are familiar. Have them think about how the traits these animals have might benefit them in their environments. If time permits, call on 1–2 groups to share their discussion.

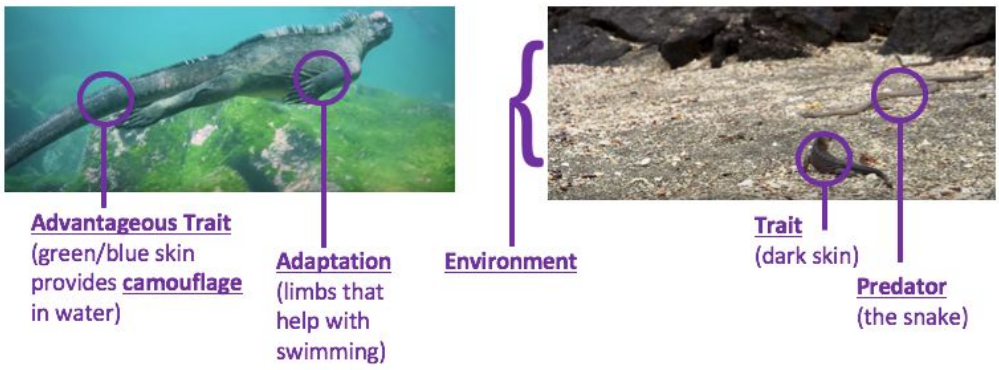
Part 3. Putting It All Together (20–25 minutes)

1. Annotated Image: Explain to your students that they will circle where they see the terms (see 2. below) in the images of the iguanas in their Student Guide and label each one. Encourage students to use the new terms more than once.

    Note: If the images are printed in black and white:

    - *Project the images of the iguanas in Appendix C: Color Images of Iguanas as students complete their annotations.*
    - *Students can use colored pencils or highlighters so that their annotations are clear.*

    The terms can make sense in multiple places. One example is shown below.



2. Students revisit the original iguana videos from Part 1. They will review their original explanation as to how the different types of iguanas came to be. Reflecting on what they learned in the activity about advantageous and disadvantageous traits in an environment, students will refine their original explanation about the iguanas. They will include as many of the scientific terms described below as possible. *Tip: Here you can supplement student answers with the information about the difference in iguanas provided in Part 1, step 1.*

   Scientific Terms

   - Trait: A characteristic or feature of an organism.
   - Adaptation: A change in structure, function, or behavior over time that improves a species' chance of survival in a specific environment.
   - Advantageous Trait: A characteristic that is beneficial to an organism's survival or reproduction.
   - Camouflage: A trait that allows an organism to blend in with its environment.
   - Environment: The surroundings in which an organism lives.
   - Predator: An animal that naturally preys on other animals.

   Potential Answer: In the first video that we watched, I noticed that the marine iguana is adapted to its environment because it has traits that allow it to live and forage underwater. For example, its clawed feet appear to be able to latch onto the rocks as it forages for food. Also, the marine iguana's long, strong tail is advantageous because it allows it to navigate and swim quickly underwater. In the second video, the land iguana (hatchling) has many advantageous traits for its environment. The coloring of the hatchling allows it to camouflage from predators, such as the snakes in the video. It also has short, strong legs, which allow it to run quickly on land.

Part 4. Quiz: Check for Understanding (5–10 minutes)
Differentiation Tip: This can be done in groups, pairs, individually, or more formally as an online quiz.
Students complete the exit ticket to check for understanding. This can be done online by selecting the **Quiz** button in Lesson 1 or on paper in the Student Guide. Answers are highlighted in bold below.

1. Being easily seen by a predator is a _____ that is disadvantageous.
   a. gene
   b. survival
   c. generation
   d. trait

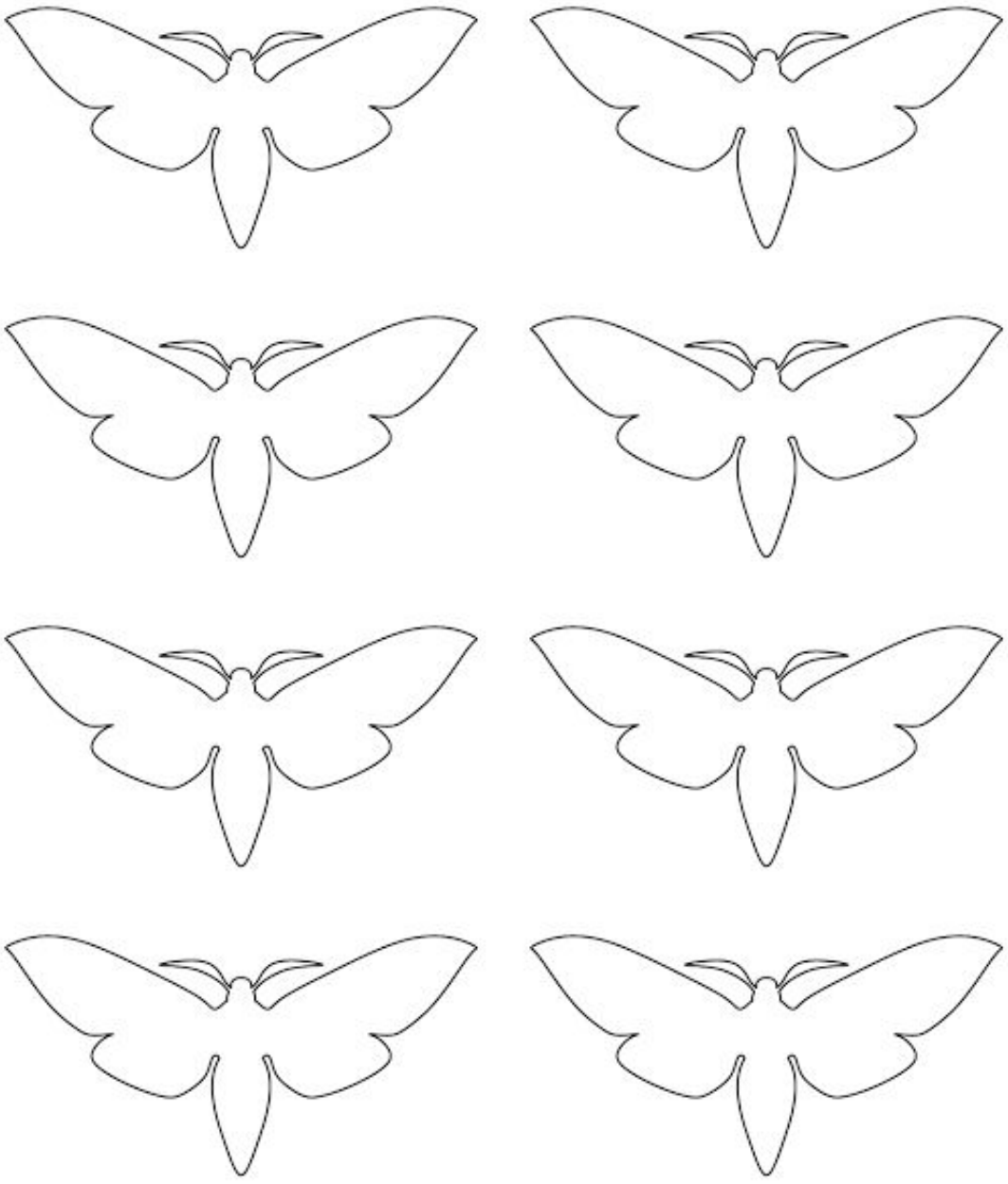
2. A gene that helps an animal survive and _____ can get passed on to its offspring.
   a. generate
   b. produce
   c. reproduce
   d. Thrive

3. An advantageous trait that becomes more common in a population is also known as a(n) _____.
   a. trait
   b. adaptation
   c. gene
   d. survival strategy

4. During the Industrial Revolution, dark ash in the air caused tree lichen that was normally white to darken. What advantageous trait helped moths camouflage themselves in this environment during this time?
   a. Flight
   b. Light wings
   c. Attraction to light
   d. Dark wings

5. Most mountain hares have white fur because they rely on snow for protection in winter. Only a few hares have dark fur. Due to global warming, there has been a decrease in snowfall, and only rarely is there any snow on the ground. How do you think this might affect the population of mountain hares?
   a. They will all continue to have fur of a similar color.
   b. With less snowfall, all white hares will die because they are now visible to predators.
   c. There will be more hares with dark fur because they will be less visible in their snow-free environment and will pass on their genes for dark fur to their offspring.
   d. All hares will migrate to a different area.

Appendix A: Moth Template



Appendix B: Sample Table, Data, and Graph for Moths Eaten

Sample Table

Write Team Name ↓	**Moth Type** →	Red	Black	Newspaper
Team A		**13**	**15**	**5**
Team B		**17**	**11**	**4**
Team C		**14**	**10**	**3**
Team D		**12**	**14**	**7**
Team E		**15**	**17**	**6**
Team F		**18**	**12**	**4**
Team G		**6**	**7**	**15**
Average # of eaten moths →		**13.6**	**12.3**	**6.3**

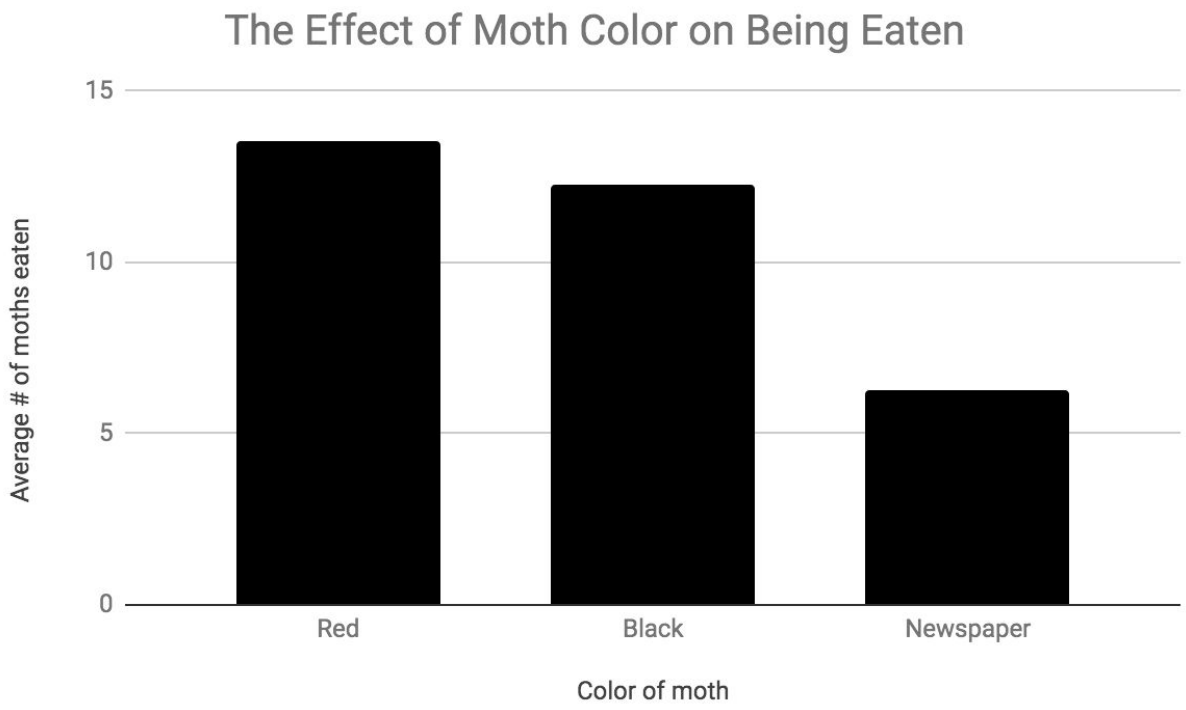
Sample Graph

Note: On the Student Guide, students are not provided with a graph title. You can choose to provide students with no title and require they come up with one on their own, or you can provide them with the following options:

a. A full title

b. The Effect of _____ on _____

c. The effect of (independent variable) on (variable)



Appendix C: Colored Images of the Iguana

Tip: It's helpful for students to view the images below in color. If digital distribution or color printouts aren't available, you can print a color version of this page to show under a document camera as your students are working on their annotated images.