4 Variation in Elephants

Unit Essential Question

How do the environment and genetics affect who we are and how we are similar or different?

Introduction

Just like plants, elephants are all different. Elephants vary in many ways, including how much hair they have, the size of their tusks, their weight, and their height. Elephants vary because they have different genes and because of the different environments they live in. "Environment" includes many components, such as the place one lives, the plants and animals around, the weather and climate, the air quality, the quantity and quality of food consumed, social connections, exercise, work, play, and even the doctors and medicine available (for elephants in zoos). In this task, students will look at how an animal's genes—specifically, elephants' genes—and environment affect height and weight.

Objectives

Students will be able to

Content

- Determine whether variations of living organisms are due to genetics or the environment.

Science and Engineering Practices

- Construct a scientific explanation about how environmental and genetic factors influence the growth of organisms.

Equity and Groupwork

- Share observations with their group.

Language

- Communicate their ideas and listen actively.

Academic Vocabulary

- environmental differences
- genetics
- inheritance
- species
- variation

Language of Instruction

- axis

Timing

This task can be completed in 3 class periods (based on 45-minute periods).

- Part I • Variation in Elephants (0.5 class period)
- Part II • Genetic Variations Resulting in Different Elephant Sizes (0.5 class period)
- Part III • Different Environmental Conditions Resulting in Variation in Elephant Sizes (1 class period)
- Part IV • Connect to the Culminating Project and Assessment (1 class period)

Materials

none

Background Knowledge

What is a species? There are actually over 20 different definitions of a species. For the sake of this task, you will use the definition most often associated with a species, the biological species concept. The biological species concept states that a species is a population of organisms that look similar and can breed and produce fertile offspring. Therefore, humans are all the same species because they look similar and can mate and produce fertile offspring. On the other hand, elephants and cats are not the same species because they do not look similar and cannot mate and produce fertile offspring. One interesting situation is donkeys and horses. Donkeys and horses can mate and produce offspring, mules, but mules are always sterile. Therefore, even though donkeys and horses look similar, they are not considered to be the same species.

There are three main existing species of elephants: the African savanna (bush) elephant, the African forest elephant, and the Asian elephant. You might conclude that because they are all different species, they must look somewhat different and cannot mate and produce viable offspring. Actually, the DNA of the African savanna elephant and African forest elephant was analyzed in 2010, and scientists conclusively determined that the two elephants are without a doubt different species. The chart below summarizes some of the physical differences between the elephants. The maps that follow show the elephants' geographical locations.

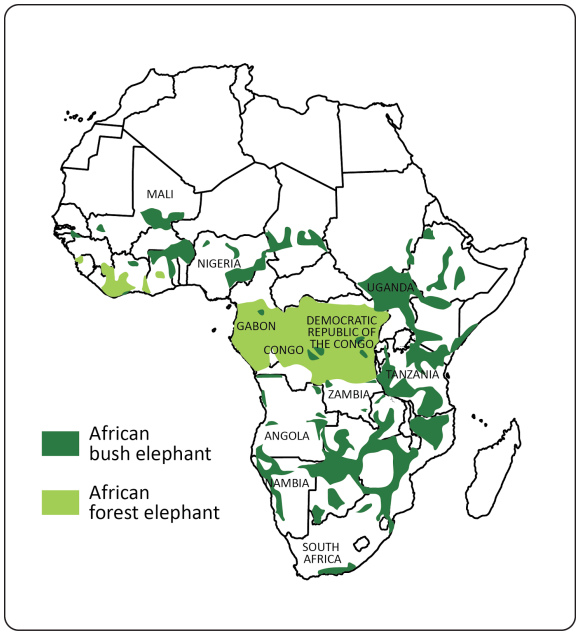
African savanna elephant | African forest elephant | Asian elephant

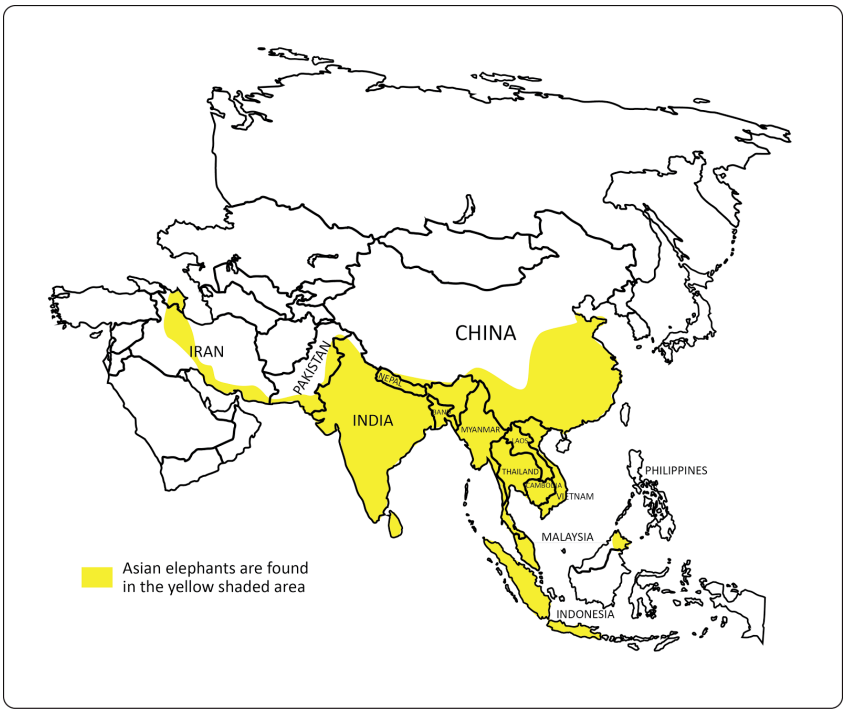
Physical Differences between Elephants

Trait	African Savanna (Bush) Elephant	African Forest Elephant	Asian Elephant
Tusks	Heavier 110–175 lbs. curved	Lightest Straighter/downward	Lighter 90–110 lbs.
Trunk	2 finger like projections at the tip of the trunk	2 finger like projections at the tip of the trunk	1 finger like projection at the tip of the trunk
Trunk rings	More rings	Medium rings	Fewer rings
Back	Dipped/concave	Dipped/concave	Arched/convex
Head	No humps on forehead	No humps on forehead	2 humps on forehead
Weight	2–7 tons	2.7–6 tons	2–5 tons

Trait	African Savanna (Bush) Elephant	African Forest Elephant	Asian Elephant
Hair	Less hair	More hair	More hair
Coloration	Darker and consistent color	Dark almost black	Freckled/patches of de-coloration
Ear size	Larger	Larger but rounder	Smaller
Skin	More wrinkled	More wrinkled	Smoother
Toenails	Fore feet: 4 Hind feet: 3	Fore feet: 5 Hind feet: 4	Fore feet: 5 Hind feet: 4

Geographical Locations of Elephants





Introduction

1. Read the introduction from the Student Edition aloud as a class. The purpose of this introduction is to connect what students learned in the previous task to the upcoming task.
2. Have students answer the question in the Student Edition on their own, and then share with a partner in a think-pair-share format.
   - In the previous task, students modeled how sexual reproduction passes on a combination of genes from parents to offspring, resulting in variations in traits. They have also looked at how the environment influences traits of organisms. The question they ask in this task is: Which is it—genetics or environment?
   - The question introduces students to a twin study that asked the same question. Students need to use their own prior knowledge to make a prediction about whether identical twins who were raised apart still have identical traits after 20 years.

Part I • Variation in Elephants

1. Place students in their project groups. Designate student roles and review the norms.
2. Have the groups discuss questions 1 and 2. Ask student recorders to write down the groups' thoughts.
3. Discuss as a class the possible causes of elephant variation. Record student responses visually for all students to see.

   Possible answers:
   - *Age*
   - *Gender*
   - *Diet*
   - *Species (type of elephant)*
   - *Health of elephant*
4. Probe a bit further and ask students whether they think their answers involve genetic or environmental influences on the trait of elephant size.
5. Have students discuss the word *species* in their groups. Then ask them to individually write a sentence that contains the words *cats* and *species*.
6. Hold a whole-class discussion about species. Ask each group to give their opinion about what the word means. There may be a variety of opinions and ways that students express their thoughts about the word. In the end, the discussion should get to the idea that species are different types of organisms, and that organisms in the same species look similar and can mate to produce fertile offspring.
   - Build off of Task 3. Once again, it is important that students understand that members of the same species (like dogs of different breeds) can reproduce, while members of different species cannot.
   - Students may bring up "exceptions" to this rule, such as ligers and mules. While lions and tigers can mate and produce offspring (liger), the liger is infertile (unable to produce its own offspring), so lions and tigers are still considered different species. The same goes for donkeys and horses.
7. After discussing the word *species* with the large group, have students work with their group to re-evaluate the sentence they wrote and revise the sentence as needed.

   Possible answers:
   Lions, tigers, bobcats, mountain lions, and housecats are all different species of cats because…
   Dogs and cats are not the same species because…
   Different species of cats are all different sizes.

Part II • Genetic Variations Resulting in Different Elephant Sizes

1. Place students in their project groups. Designate student roles and review the norms.
2. Introduce Part II by asking students what different species they see on the graph. Review the word *species.*
3. Briefly explain that in this activity, students will analyze the data in the graph about elephant sizes and then construct a claim, evidence, reasoning explanation. Remind students to use numbers from the graph when supporting their claim. Remind students to listen to each other's ideas before making a final decision as to what to write.
4. Have students work in their groups to answer the three parts of question 1 in the Student Edition.
5. Have students individually write claim, evidence, reasoning explanations. Provide sentence stems as needed based on the sample answers below.
6. Bring the class together to discuss the questions. Ask each group to share one of their comparative statements about Graph 1. Record their statements on the board. Positively reinforce the use of numbers in the statements.
7. Have students share their claim, evidence, reasoning explanations.
    - Optional: Have students exchange their explanations with a partner and get written feedback. Give students time to make edits based on the feedback they receive.

Possible answers:

Claim: After analyzing Graph 1, make a claim about elephant heights and elephant species.

- *Different elephant species have different heights.*
- *The African savanna elephant species is much taller than the African forest elephant species.*
- *All elephant species are much taller than the human species.*

Evidence: Use evidence from the graph to support your claim. Use numbers when stating your evidence.

- *On average, the African savanna elephant is 4 m tall, the Asian elephant is 3.3 m tall, and the African forest elephant is 2.7 m tall.*
- *On average, the African elephant is 0.7 m taller than the Asian elephant and 1.3 m taller than the African forest elephant.*
- *On average, the African savanna elephant is 1.3 m taller than the African forest elephant.*
- *On average, elephants are anywhere from 1 to 2.3 m taller than humans.*

Reasoning: Use a scientific concept to connect your evidence to your claim.

African savanna elephants, African forest elephants, and Asian elephants are all different species. This means that they all have different genes. Since genes determine how tall the elephants will be, the different species of elephants have different heights due to genetics or inherited traits.

Point out to students that there can still be a lot of other variables that affect height. Environmental factors, such as climate differences, food availability, etc., can also affect elephant size.

Part III • Different Environmental Conditions Resulting in Variation in Elephant Sizes

1. Place students in their project groups. Designate student roles and review the norms.
2. In a large-group setting, introduce students to Part III by asking them to look at the two pictures in their Student Edition and discuss where elephants might live. Point out that the same species of elephants usually live in similar regions, but that there are environmental differences in similar regions due to climate change, weather change, human impact, etc. In this task, students will determine what and how environmental differences might affect an elephant's growth.
3. Have students discuss questions 1 and 2 in their groups. Tell students to use their science notebook to individually take notes about the discussion (as well as write their answers) so that they can remember details for participation in the group discussion later on.
4. Have students answer questions 3 and 4 individually.
5. Bring students together to discuss the questions. Question 1 highlights the crosscutting concept of cause and effect. Ask students to elaborate on their answers by asking why and how the environmental factors may affect the elephants.

   Possible answers: Amount of food, amount of rain, temperature (climate), amount of water in the rivers, type of food, amount of walking they do, stress (number of predators in the area)
6. For question 2, make sure that students understand the graph and the information that it shows.

   Possible answers to question 2c: Different amounts of food, different types of food in the zoo, different amounts of vitamins and minerals in their food, different feeding times, different sizes of their cages.
7. Have students share their claim, evidence, reasoning statements.
   - Optional (encouraged for ELL students): Have students exchange their explanations with a partner and get written feedback. Give students time to make edits based on the feedback they receive.

Claim: After analyzing Graph 2, make a claim about the weights of the orphaned Asian elephants. *After 44 weeks, the two Asian elephants grew to have different weights.*
Evidence: Use evidence from the graph to support your claim. Use numbers when stating your evidence. *After 44 weeks, Savannah grew to be 300 kg and Sierra grew to be 255 kg.*
Reasoning: Use a scientific concept to connect your evidence to your claim. *It is likely that an environmental difference—their diet—influenced their weight gain. Elephants of the same species usually weigh about the same, so there must be another reason why they grew to different weights. Environmental influences can affect traits, and since we know the elephants were fed differently, it is a good possibility that diet affected their weights.*

8. Question 4 highlights the crosscutting concept of cause and effect. The goal is for students to apply concepts they learned about elephants (the influence of genetics and the environment) to humans. This discussion can eventually lead to the concept that there is an extreme amount of diversity in life when looking at humans and all living things. One additional conversation may address why diversity in life so important to life on Earth.

9. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following question from their Student Guide: At the beginning of this task, you were asked to think about a study of identical twins raised apart and predict whether these identical twins still had identical traits after 20 years. Look back at your response. After what you have learned about genetics and environment through this task, how would you add to or change your ideas? Is there any evidence from this task that you can add?

   There is no right answer, but encourage students look back at the prior knowledge question from the start of class. They should not change their initial answer, but rather use this reflection space to modify their original idea or add evidence they have collected over the course of this task.

Part IV • Connect to the Culminating Project and Assessment

1. Have students independently complete the task 4 section of the Individual Project Organizer in class.
2. Collect the Individual Project Organizers and assess using these criteria:
   - The "Constructing Explanations and Designing Solutions" row of the Science and Engineering Practices Rubric
   - A criterion of your choice.
3. Return the Individual Project Organizers. Give students time to make revisions based on one of these two options.
   - Have students make changes to their Individual Project Organizer according to your comments. (This could be done for homework, depending upon students' needs and/or class scheduling.)
   - Ask students to exchange their Individual Project Organizer with a partner, and give partners 5 minutes to provide written feedback. Then allow students time to make changes to their work according to the feedback.