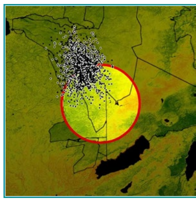

Investigating Science Practices in Serengeti: Nature’s Living Laboratory

hhmi | BioInteractive

Activity
Educator Materials

OVERVIEW

In this activity, students engage in key science practices that scientists used to figure out ecosystem dynamics in the Serengeti. Students first carefully observe a phenomenon, then work through what is happening in the Serengeti by using the science practices to answer investigative questions.

The science practices in this activity are the eight NGSS Science and Engineering Practices (SEPs) as outlined in the *Framework for K-12 Science Education*:

- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Each section of the “Student Handout” corresponds to one of the eight SEPs. More information about how to use and distribute the handout sections is provided in the “Procedure” below.

This activity uses video clips from the short film *Serengeti: Nature’s Living Laboratory* and card sets from the activity “Using Three-Dimensional Learning Cards in the Science Classroom.” Refer to those resource webpages for more information about these materials.

Additional information related to pedagogy and implementation can be found on this resource’s webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

- Science practices build on observations and help make sense of the natural world.
- Science practices are meant to be used in a flexible, nonlinear order that depends on the investigation.
- Scientific inquiry is never complete, as new discoveries lead to new questions and new investigations.

STUDENT LEARNING TARGETS

- Make observations and develop explanations of phenomena.
- Model how scientists use science practices and work together across different science domains.
- Use science practices in a way that demonstrates their interdependence.

PRIOR KNOWLEDGE

It is helpful for students to have had some exposure to the Science and Engineering Practices (SEP) and Crosscutting Concepts (CCC) from the Next Generation Science Standards (NGSS) and *A Framework for K-12 Science Education*, including in previous grades. Introduce or review these with students as needed. For more information, refer to the activity “Using Three-Dimensional Learning Cards in the Science Classroom.”

MATERIALS

- copies of the "Student Handout"
- SEP and CCC cards from "Using Three-Dimensional Learning Cards in the Science Classroom"
- access to video clips; YouTube links are provided in the "Student Handout" and below:
  - Asking Questions and Defining Problems
  - Developing and Using Models
  - Planning and Carrying Out Investigations
  - Analyzing and Interpreting Data
  - Using Mathematics and Computational Thinking
  - Constructing Explanations and Designing Solutions
  - Engaging in Argument from Evidence
  - Obtaining, Evaluating, and Communicating Information

TEACHING TIPS

- Print or electronically share files for the SEP and CCC cards from "Using Three-Dimensional Learning Cards in the Science Classroom."
  - A PDF file is provided as a printable option. You can cut out the cards and laminate them for repeated use.
  - Individual card images (JPGs) are provided in the "Card Images" ZIP file. You can use a virtual whiteboarding or collaboration software (e.g., Google Jamboard, Miro) in which students can move and annotate card images.
- Each section requires viewing clips from the short film *Serengeti: Nature's Living Laboratory* before proceeding. It is *not* recommended to show the entire film until after students have finished all sections.
- Although each section focuses on a specific science practice, it is key that students use multiple practices together to figure out the problem presented.
- Students can write observations and answers to the questions in the "Student Handout" or in other places (e.g., in notebooks, on separate paper, or in an online document).
- If you incorporate peer review at any point, include guidance for how you would like students to provide their feedback. For example, you could have them give constructive comments to or ask clarification questions of their peers.

PROCEDURE

The "Student Handout" for this activity has eight sections, one for each science practice. As scientific inquiry does not progress linearly, these sections are not meant to be used in any particular order. They can be rearranged to reflect the back-and-forth nature of the practices, and students are prompted at the end of each section to consider which practice to engage in next.

There are multiple ways to use the eight sections of the handout. Some approaches are as follows:

- **Use all sections together.** It is vital for students to recognize that science practices are *not* used in isolation. To this end, you could use all eight sections of the handout together to show how all the practices are used to answer questions and solve problems.
  - It is recommended to begin with the section for "Asking Questions and Defining Problems." In that last question of this (and every other) section, students are asked which science practices to engage in next.

They can then proceed to the section for one of their chosen practices. They can continue choosing practices at the end of each section until they have completed all eight sections/practices.

- **Use individual sections.** You can present an individual section as a standalone activity to highlight a single science practice. However, students should still identify the other practices required at the end of the section. (It is not recommended to focus only on a single practice, as it is critical for students to recognize that the practices are used together.)

Students can work on the sections of the handout individually or in small groups:

- For **individual students**, hand out only one section at a time so students are focused on that practice and not working ahead.
- For **student groups**, you may:
  - Have the entire group work through the same sections together.
  - Give each group member a different section to work through. They can then share what they figured out with the other members of their group.
  - Use a "jigsaw" approach where different groups work on different sections. After each group finishes their section, form new groups where each member is an "expert" on a different science practice, then have them share with each other.

ASSESSMENT GUIDANCE

Below are summaries of the main takeaways for each section/practice in the "Student Handout." Note that many student answers for the handout questions will vary. The last three questions for each section are the same. For these questions, students can pick any of the cards or practices that they would like to explore next.

For each section, students should use the SEP and CCC cards when asked to do so. This will allow them to reflect on the science practices and crosscutting concepts that they used. This will also help them choose the next step of the scientific process and science practice that makes sense to them.

SCIENCE PRACTICE: Asking Questions and Defining Problems

Procedure/Notes

The practice of asking questions allows students to formulate investigative questions based on their observations of phenomena. It also allows them to practice writing questions that are clear and motivated by a wide variety of information (e.g., video observations, data and graphs, etc.), much like the questions of the scientists in the video clip.

This section can be used to help students review and revise their questions and the questions of others. This practice naturally leads them to engage in other practices so that they can answer the questions they posed after observing the phenomenon. Students should focus on the wildebeest phenomenon as presented in the video clip.

Sample Student Responses

1. What were some of your questions as you watched this video? Write at least three questions that could be studied in the Serengeti.
   Student responses will vary, but it is important to allow all students to have a voice when sharing out questions.

2. Do you think that some of the scientists in the video asked similar questions? If so, what do you think may have been their motivation for asking these questions?
   Student responses will vary but should reflect what students learned from scientists in the film clip.
3. What problems could be studied based on the scientists' observations in the Serengeti?
   Student responses will vary but should reflect what students learned from scientists in the film clip.

SCIENCE PRACTICE: Developing and Using Models

Procedure/Notes

Models can be used for a variety of reasons. In this case, the trophic pyramid model is provided as a starting point to allow students to consider the relationships among the different components (organisms) in the ecosystem. Providing students with a visual representation allows them to think through what they know about ecosystems and formulate new questions about what they may still want to figure out. As models are developed and used, they can change as students are presented with new information. This allows them to develop an explanatory model around these complex science ideas.

In this section, students will make observations of the initial model to consider how the wildebeest may be impacted by other organisms in their ecosystem. They then can revise the model, based on the new information from the film clip, to represent the two possible models of how the wildebeest population may be regulated.

If students are unable to draw directly on the images in the handout, they can create new images of their models by drawing on another page or by using shapes/pictures from a software program. Let students know if you would like them to use a specific method.

Sample Student Responses

1. How might the wildebeest population be impacted by the other organisms in the image?
   Student responses will vary. Some major points will likely include how predators impact wildebeest populations, as well as how food availability can impact wildebeest.
2. Develop a model of the interactions among the organisms in the image. You can make your model by adding labels or symbols directly to the image on this page. Or you can create a new image of your model by drawing on another page or by using shapes/pictures from a software program. Explain the model that you developed in writing below.
   Student models may vary.
3. Develop the two models of wildebeest regulation, including labels that help explain how each model works in this ecosystem. As in Question 2, you can make your models by adding labels or symbols directly to the "Model 1" and "Model 2" images on this page.
   Student models may vary. The two models described in the video clip are of bottom-up regulation (the wildebeest population is limited by producers, their food supply) and top-down regulation (the wildebeest population is limited by predators).

SCIENCE PRACTICE: Planning and Carrying Out Investigations

Procedure/Notes

Planning and carrying out investigations is how students collect data and gather evidence. The results of investigations can help us create explanations and answer questions — and generally also brings about new questions that can lead to further investigations. The practice of planning and carrying out investigations also provides opportunities for students to consider relationships among the variables they are studying.

There are many ways that scientists investigate phenomena, including active hands-on inquiries (like that of the scientist in the video), research-based approaches that compile evidence from existing studies and data sets, or combinations of both. In this section, students summarize the steps laid out by the scientist in the film clip to better evaluate the variables and possible relationships that would help explain this phenomenon.

Sample Student Responses

1. Which two limiting factors were thought to possibly regulate wildebeest populations?
   Predators and food (plant/producer) availability.
2. What question was Mduma trying to answer through this investigation?
   Students will likely mention questions about whether more wildebeest are dying due to predators or starvation.
3. Describe each step that Mduma took in this investigation, and why that step was important.
   Student answers will vary, as some students will tease out more details than others. Key steps include locating carcasses, examining the carcasses by making observations of the bones and tissues, etc.

SCIENCE PRACTICE: Analyzing and Interpreting Data

Procedure/Notes

Students analyze and interpret data to identify evidence from investigations to answer their questions and build on their own explanations. Not all data can be used as evidence, so it is important for students to distinguish what data mean. Analyzing the data will also help them identify limitations in investigations or their explanatory models. Also, data analysis often leads to more questions and allows students to make predictions.

Using data allows students to engage in sensemaking around phenomena. This enables students to use evidence to change and/or create their own ideas about important science concepts, rather than just being told about them. The results of data analysis should elicit student responses that highlight the patterns and cause-and-effect relationships they observe.

Sample Student Responses

1. What patterns do you notice in the graph?
   Responses should include that the larger the prey, the less they are targeted or killed by predators.
2. Why do you think both the resident wildebeests and those that migrate were included on this graph?
   Wildebeest were divided into residents vs. migrants on the graph to highlight the difference in predation between the groups.
3. Explain the relationship(s) in the data using the patterns you identified.
   Students should elaborate on the idea that it is more difficult for predators to take down larger prey. So, larger prey are hunted or killed less often than smaller prey.
4. What new questions do you have after viewing the video?
   Student responses will vary.

SCIENCE PRACTICE: Using Mathematics and Computational Thinking

Procedure/Notes

Math and computational thinking is another way to make sense of a phenomenon. Information gathered through careful observation, investigation, and data collection can be analyzed through qualitative or quantitative means. Engaging in computational thinking allows students to make sense of numbers to determine whether patterns or relationships exist within or among data sets.

Math and computational thinking is not just about doing calculations, but also about students making sense of numbers that help support their understanding of science ideas. It is necessary to consider different variables in different contexts to understand a concept, such as complex relationships among components of an ecosystem.

In this section, students use numbers to inform decisions about wildebeest populations and their carrying capacity. Students should discuss how they would go about doing these calculations in ways that make sense to them and then attempt to explain how their calculations make sense in this context.

Sample Student Responses

1. By what percentage did the wildebeest population increase from 1961 to 1977?
   Student responses should be around 500%. There may be some variation depending on how students estimate the numbers on the graph.
2. Based on the graph, what is the carrying capacity for this population?
   The carrying capacity is shown by the red dashed line, which is around 1,300,000 wildebeest.
3. How do you think scientists determined the population's carrying capacity? Provide evidence from the video and/or the graph to support your reasoning.
   Student responses may vary. They may suggest that scientists examined the long-term population data to determine the trend in population size over time.
4. What do you think would happen to the carrying capacity if there was a severe drought in this area? Explain your thinking.
   Students responses may vary. However, they should include some mention of decreases in food (plant/producer) availability.

SCIENCE PRACTICE: Constructing Explanations and Designing Solutions

Procedure/Notes

Explanations cannot be constructed without first engaging in other practices that yield evidence. Once students have evidence, they can begin putting the pieces together to help in their sensemaking, which will lead them to build on their conceptual understanding of the phenomenon. Once students have made sense of the information, they can create an explanation that illustrates their understanding of, for example, the complex relationships among components of an ecosystem.

In this case of wildebeest and fire, students should use the data to explain the relationship that exists and how understanding this relationship could impact other ecosystems.

Sample Student Responses

1. Explain what this data tells you, identifying any relationships shown.
   Student responses may vary. They will likely include that the wildebeest population increased as the area burned decreased.
2. Based on the video, construct an explanation of the relationship between wildebeest and wildfires.
   Wildebeest consumed many more grasses as their population increased. So there was less dry grass to burn, which decreased the chance of wildfires.

3. How could understanding this relationship help people manage wildfires?
   Student responses may vary and could include the clearing of dry plant material in areas with a higher incidence of fires.

SCIENCE PRACTICE: Engaging in Argument from Evidence

Procedure/Notes

Argumentation cannot be used without evidence, so students should observe data and make decisions as to what data supports their argument. They also need to consider different models and/or explanations to determine which is best supported.

In this section, students make observations of data, cite which elements will serve as evidence, and finally explain their reasoning for each piece. Students may need support for writing simple evidence statements and using them to support their reasoning, as many students struggle with the difference between evidence and reasoning. Students should cite evidence that identifies specific areas of "greenness" and how wildebeest move toward greener areas when they migrate.

Sample Student Responses

1. Based on these data, create an argument that predicts why you think these wildebeest migrate the way they do.
   The wildebeest tend to travel to where there is more vegetation (food).

2. One argument is that wildebeest must migrate to support their large populations. Support this argument using **three** pieces of evidence from the video and maps. Provide reasoning for how each piece of evidence supports the argument.
   Student responses will vary. Students may cite the wildebeest (black dots) being found in places with more vegetation (greener areas on the map), or the wildebeest avoiding places with less vegetation (orange and yellow areas) due to lack of food in different months.

SCIENCE PRACTICE: Obtaining, Evaluating, and Communicating Information

Procedure/Notes

Science ideas cannot be accepted or rejected until they are made public. Communicating science ideas involves allowing others to evaluate them and to either support or refute those ideas based on other pieces of evidence. Allowing others to evaluate claims or ideas can strengthen our collective understanding of a scientific phenomenon.

In this case, the video clip explains that scientists working on different Serengeti projects found many different connections among their investigations and, as a result, all developed a better understanding of the complex relationships that existed there. Students should respond to questions in this section highlighting those relationships and why making connections like these is important.

Sample Student Responses

1. What different aspects of the Serengeti were the scientists studying?
   Predators, trees, burning, rainfall, and herbivores.

2. Why was it critical for the scientists to review each other's work even though they were studying different things?
   All the individual projects were interconnected and were related to the wildebeest population. So

reviewing other projects could help the scientists learn more about the overall system and things that could be related to their own work.

3. How does the video emphasize the importance of communication in science?
Student responses may vary. They may include that scientists must communicate with others to learn more about the problems they are trying to figure out.

OPTIONAL EXTENSIONS

You could follow this activity with other BioInteractive resources, including:

- *Serengeti: Nature's Living Laboratory*: This short film is the source of the clips used throughout this activity. Students can watch the entire film after they have completed all sections of this activity.
- "Population Regulation in the Serengeti": This activity, which also uses clips from the *Serengeti: Nature's Living Laboratory* film, explores factors that affect wildlife population sizes in the Serengeti. Students can use this activity to learn more about the Serengeti and continue their use of science practices.
- "Nutrient Cycling in the Serengeti": This card activity explores how nutrients move through the Serengeti ecosystem. Students can also use this activity to learn more about the Serengeti and continue their use of science practices.

CREDITS

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