Shape of Life
The Story of the Animal Kingdom

Phenomena-Driven Inquiry

Engaging Students with Observations of Scientific Phenomenon

Overview

In this lesson, students engage in the practice of science. They observe behaviors using Shape of Life video(s) with the audio and closed captioning turned off. They try to figure out what the phenomenon (the behavior) is and how it might help the organism(s) to survive. Working in pairs, they make a hypothesis about what they are observing with evidence to support their hypothesis. Possible Enrich/Extend activities listed at the end of the lesson include a deeper dive into the phenomenon and helping to guide students through the process of planning and conducting their own investigation into a phenomenon they can observe directly.

Objectives

- Students will construct a hypothesis about an observed phenomenon.
- Students will explain their hypothesis and arguments/evidence to support it orally and in writing.
- *Optional extensions:*
    - Students will explain other ways in which scientists use the Science + Engineering Practices and Crosscutting Concepts of the NGSS orally and in writing.
    - Students will plan and conduct their own scientific investigation into an observed phenomenon.

Subjects

Science, Writing, Reading

Grades 3–16

Time

30– 90 minutes

Vocabulary

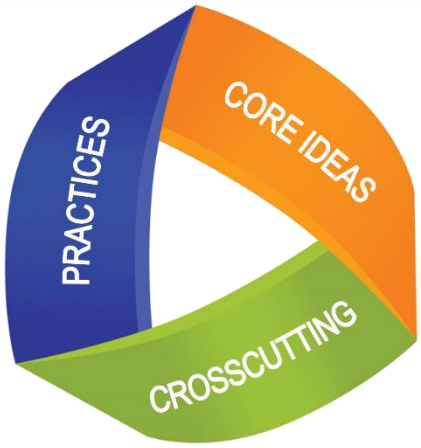
Will vary depending on videos used, but can include biological evolution, hypothesis, patterns, scale, proportion, systems, system models, and other terms used in the Science & Engineering Practices and Crosscutting Concepts of the Next Generation Science Standards

Standards		Middle School / High School
Next Generation Science Standards	Sample Performance Expectations met, depending on videos used and approach to lesson	HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
	Sample Disciplinary Core Ideas met	LS4: Biological Evolution: Unity and Diversity LS4.A: Evidence of Common Ancestry and Diversity LS4.C: Adaptation LS1: From Molecules to Organisms: Structures and Processes LS1.A: Structure and Function LS1.B: Growth and Development of Organisms

	Crosscutting Concepts (all can be incorporated in lesson)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter • Structure and Function • Stability and Change
	Science & Engineering Practices (all can be incorporated in lesson)	• Asking Questions + Defining Problems • Developing and Using Models • Planning and Carrying Out Investigations • Analyzing and Interpreting Data • Using Math and Computational Thinking • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information
Common Core ELA	Writing	7
	Speaking & Listening	4, 6
	Language Standards	1, 2, 3, 6

Teacher Background

Phenomena-Driven Inquiry refers to the process of using observable scientific phenomena to engage students and help guide the learning process. It can be used as part of **Three-Dimensional Learning** referred to in the Next Generation Science Standards (NGSS) to weave together the Science and Engineering Practices (SEPs), Crosscutting Concepts (CCs), and Disciplinary Core Ideas (DCIs) in student learning. Through the process of DOING science and engineering, students apply the Three Dimensions, helping them see the interconnections among disciplines as they develop their scientific, critical thinking, math, and English Language Arts (ELA) skills. This will help prepare students to conduct their own meaningful and reliable investigations if that Enrich / Extend activity is incorporated.



Materials + Preparation

- One or more Shape of Life videos of animal behaviors, such as:
  - "Cnidarians: Anemones Fight" (2:49): shapeoflife.org/video/cnidarians-anemones-fight

- "Flatworms: Reproduction" (1:44): shapeoflife.org/video/flatworms-reproduction

- "Sponges: Filter Feeding Made Visible" (2:17): shapeoflife.org/video/sponges-filter-feeding-made-visible

- Science notebook and pencil or pen for each student
- Computer with Internet connection and data projector to show video to whole class
- Whiteboard or chart paper and markers

Teaching Suggestions in the 5E Model

Engage

1. Students observe a phenomenon and generate ideas about how/why it happens. (3 – 5 min.)

    - Show students an interesting scientific phenomenon. Choose a video clip from Shape of Life. Mute the audio and turn off closed captioning if it exists. Good examples include:
        - "Cnidarians: Anemones Fight" (2:49): shapeoflife.org/video/cnidarians-anemones-fight
        - "Flatworms: Reproduction" (1:44): shapeoflife.org/video/flatworms-reproduction
        - "Sponges: Filter Feeding Made Visible" (2:17): shapeoflife.org/video/sponges-filter-feeding-made-visible
    - Ask students to think about how to describe the behavior and what is going on in the video. Ask them to turn to a neighbor and discuss their ideas, recording them in science notebooks or on scratch paper.
    - After a minute or two of generating and recording their ideas, ask the neighbors to share their best ideas with the class about what's going on. For example, what are the anemones doing?

Explore

2. Students construct hypotheses about the phenomenon. (5 – 10 min.)

    - Show the video again to the entire class with the sound off, or ask students to choose from other short videos, such as those listed above.
    - Ask the students to work in groups of 2 – 3 to construct a hypothesis about what is happening and to make clear arguments/evidence to support their hypothesis. Clarify the meaning of the word **hypothesis**, if necessary,
    - Ask each group to present its hypothesis and arguments/evidence to support it to the rest of the class.
    - You or a student volunteer should write each theory on the board or via a data projector for all to see.
    - Ask the class to vote on the most likely hypothesis.

Explain

3. Discuss the observed phenomenon. (3 – 5 min.)

    - Play the video again for the class with the sound on.
    - Discuss the phenomenon with students and compare their hypotheses with what's really happening. Provide more background about it, if desired. For example, explain that some anemones can be territorial and will fight to defend their piece of rock, often even maintaining a "no man's land" between groups. You might show and explain video of nematocysts so students understand that anemones have stinging cells on their fighting tentacles: shapeoflife.org/video/nematocyst-animation-fighting-tentacles.
    - For more background on how sponges feed through filter feeding, see the Shape of Live videos:
        - "Sponges: Origins" (14:02): shapeoflife.org/video/sponges-origins
        - "Sponge Animation: Wild Ride Through a Sponge" (2:19): shapeoflife.org/video/sponge-animation-wild-ride-through-sponge
    - For more background on flatworms, see the Shape of Live videos:
        - "Flatworms: The First Hunter" (9:54): shapeoflife.org/video/flatworms-first-hunter
        - "Flatworm Animation: Reproduction" (0:48): shapeoflife.org/video/flatworm-animation-reproduction

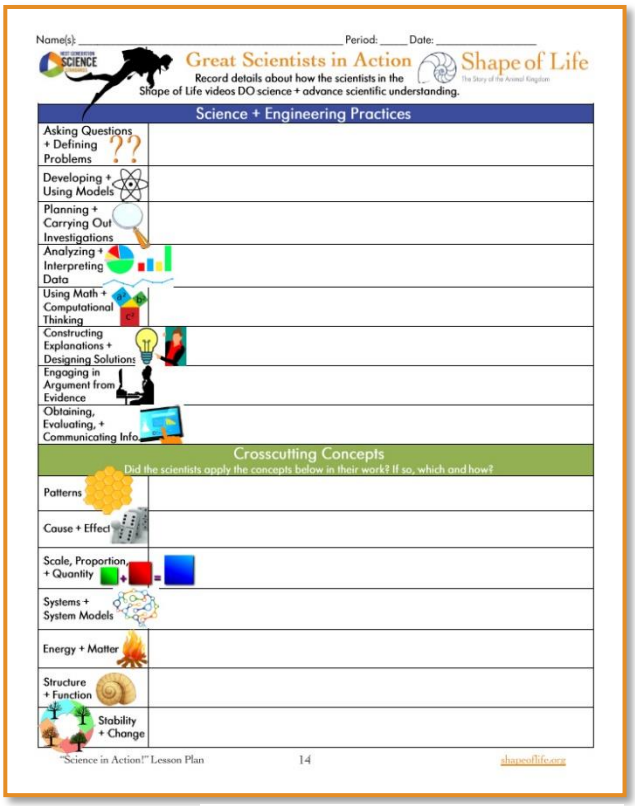
4. Closing discussion / reflection (2 – 4 min.)

    - Close with a discussion of how scientists investigate phenomena.
    - Students can be asked to reflect on what they learned in the lesson in writing in science notebooks.

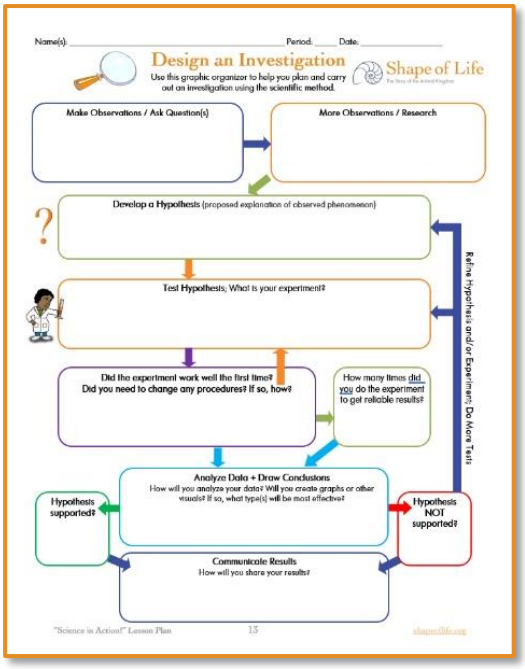
Extend / Enrich

- Dive deeper into the scientific phenomenon. (5 – 20 min.)
    - For example, students can learn more about anemones' lifestyle, relatives, etc. by watching other Shape of Life videos and/or doing research.
    - Students can present their findings to the class. Provide a rubric so students know how they will be assessed, such as the one at the end of the "Science in Action!" lesson: shapeoflife.org/lesson-plan/sol/science-action.

- Students reflect on more ways scientists engage in the practice of science. (5 – 20 min.)
    - Pass out copies of the "Great Scientists in Action!" graphic organizer found at the end of the "Science in Action!" lesson from Shape of Life: shapeoflife.org/lesson-plan/sol/science-action
    - Discuss the NGSS Science and Engineering Practices (SEPs) and Crosscutting Concepts (CCs) listed on the sheet.
    - Explore other concepts and videos explained in the "Science in Action!" lesson plan.
- Students can plan (and possibly also conduct) their own investigations. (30 min. or more)
    - Challenge students to think about how they might design their own investigation to prove how and/or why an observed phenomenon occurs. Use prompts like:
        - "How might we design an investigation using an organism (living or already deceased)?"
        - "Are there plants, animals, or fungi in our schoolyard that we could investigate? For example, could we test the rate at which different seeds of garden plants germinate and grow under different conditions?"
        - "What materials might we need (and already have) to test interesting phenomena we observe?"
        - "How might we collect data?"
        - "How might we analyze the data and share it with others?"
    - Pass out copies of the "Design an Investigation" organizer found at the end of the "Science in Action!" lesson: shapeoflife.org/lesson-plan/sol/science-action.
    - Have students form groups of 2 – 4 and use the organizer, their science notebooks, and/or a computer to help them develop an investigation plan. After groups start developing their ideas, ask the groups with especially interesting ones to share them with the class. This will help them refine their ideas and assist the other groups with developing their plans.
    - Decide as a class which investigation(s) the students want to conduct. Each group might want to conduct their own unique experiment, or the groups could break a larger investigation into smaller parts for each of the groups to investigate.
    - **Ideas for student projects** if they need help generating them:
        - The proportions of different food groups represented in student lunches



"Great Scientists in Action" graphic organizer found at the end of the "Science in Action!" lesson



"Design an Investigation" graphic organizer found at the end of the "Science in Action!" lesson

        - How and why populations of endangered species are changing
        - Water and/or air quality in your area
        - Groups could test the growth rate of plants under different conditions: varying amounts of light, water, salt, compost mixed into the soil, acidity, etc.
        - Investigate the clouds above your school over a period of time and which types of clouds produce the most precipitation. The GLOBE Observer app from NASA can help support these studies and share the data with other groups around the world: observer.globe.gov/do-globe-observer
        - Note at the above link how GLOBE Observer can also help support investigations into mosquitoes, trees, and land cover.
        - Are there more crayfish in freshwater bodies in urban areas or rural areas?
    - Students could also create presentations or videos about their investigations and results.

- Conduct a field study to support students observing natural phenomena and/or carrying out investigations. (Will vary)
    - Take students on a field study to a tidepool, wetland, aquarium, stream or other natural area where students can observe organisms and their ecosystems firsthand.
    - Be sure students are prepared with appropriate clothing, safety rules, ways to avoid damaging the ecosystem, etc.
- Discuss current events related to one or more scientist and their research.
  (1 – 20 min.)
    - Find some local news highlighting scientific findings. This will make the activities and discussions more relevant and personal to the students.
    - Other important findings in the news, such as the impacts of climate change and ocean acidification on coral reefs, would also stimulate thinking and discussion.

Evaluate

5. Students can present the results of their research projects to the class if they will be completing them.
    - Provide a rubric such as the one at the end of the "Science in Action!" lesson (shapeoflife.org/lesson-plan/sol/science-action) so students know how they will be assessed.
    - Completed projects can also be displayed on classroom and/or school walls.

Expand Knowledge + Skills

Related Lesson Plans / Activities / Videos

- "Cnidarian Adaptations." Shape of Life: shapeoflife.org/sites/default/files/Cnidarian%20Adaptations%20-%20Shape%20of%20Life.pdf
- "Jellyfish and Anemone Anatomy (Cnidaria)." MacOrganisms2: youtube.com/watch?v=eC5-y_oTI2Q
- "Science in Action!" Shape of Life: shapeoflife.org/lesson-plan/sol/science-action
- "Our Chordate Family Tree." Shape of Life: shapeoflife.org/lesson-plan/sol/our-chordate-family-tree

Scientific Method Background

- "Steps of the Scientific Method." Science Buddies: sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method
- "The Scientific Method." Khan Academy: khanacademy.org/science/high-school-biology/hs-biology-foundations/hs-biology-and-the-scientific-method/a/the-science-of-biology
- "Scientific Method." Stanford Encyclopedia of Philosophy: plato.stanford.edu/entries/scientific-method

Standards and Three-Dimensional Learning

- Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned: nextgenscience.org/framework-k%E2%80%9312-science-education
- Examples of what NGSS looks like for California students can be found in the 2016 Science Framework for California Public Schools: cde.ca.gov/ci/sc/cf/documents/scifwchapter4.pdf
- "Three Dimensional Learning." Next Generation Science Standards: nextgenscience.org/three-dimensions
- "NGSS EQuIP Rubric: 3-Dimensional Learning." Video. TeachingChannel: nextgenscience.org/sites/default/files/EQuIPRubricforSciencev3.pdf
- NGSS EQuIP Rubric for Lessons & Units: Science. Ver. 3.0: nextgenscience.org/sites/default/files/EQuIPRubricforSciencev3.pdf
- Common Core State Standards and links to the complete documents: corestandards.org

Appreciation + Thanks

Thank you for using Shape of Life resources and helping to inspire the next generation of thinkers and scientists! We also greatly appreciate all of the scientists who have been collaborating with us and agreed to be filmed.

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Shape of Life

We welcome your questions or comments.