Pond Unit Storyline

7 days

5.Matter and Energy in Organisms and Ecosystems

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Students who demonstrate understanding can:

5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. [Clarification Statement: Examples of models could include diagrams, and flow charts.]

5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

water, and polar ice caps, and does not include the atmosphere.]

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Driving Questions	Learning Goals	Activities
Lesson 1 **What are models?** **What criteria can we use to evaluate models?** **Anchoring phenomenon--Why are fish dying?**	Students develop a definition of models and are given a class list of model criteria. Epistemic learning goals (ELG): a. As a community we have criteria that we can use to develop, evaluate, and revise models. These are shared norms we all agree to and follow. Students will suspect that pesticides and fertilizer may be related to the fish deaths Epistemic learning goals (ELG):	<u>Activities</u> - *Introduction to Modeling*-- As a class, students will first discuss what is a scientific model. We will give them the definition and an example. - *Class criteria list*-- As a class, we will look at the list of criteria for good models. Students will use the criteria list to review pairs of models and decide which is best and why. This list will be posted publicly and used throughout the unit. - *Intro to MEME*-- As a class, we will use a simple model to demo MEME, which is an online modeling tool. Students will get used to the tool and features in the system. - *Anchoring phenomenon*-- As a class, students will watch a video to introduce the pond phenomenon. The video shows a local community problem-- fish are dying in a local pond. A representative from FRESH Org reports the problem and gives students a mission. - *Evidence*-- In small groups, students will engage with evidence set 1 to construct the initial model. The evidence set may lead students to generate several ideas of fish dying, including the use of fertilizers and pesticides. The evidence set includes:

	a. There are often alternative explanations of any one phenomenon. b. We can use evidence to rule some of these out and narrow the field of possible explanations. c. We may also need to gather more evidence relating to any models that are left.	- E1.1 Story scenario - Bar graph showing high fish death rate from July to September in Blue Pond. - E1.2 Farmer's inventory list - An inventory given to Fresh Org from local farmers regarding their inventory of materials they use on their crops (pesticides, fertilizer). - *Modeling*- students will work in small groups to construct their MEME models based on the evidence. - *Revisit DQ and what we figured out* -- We are not given much information, and we suspect that pesticides and fertilizer may be the reasons for fish dying, but we need more evidence to figure out. This drives Lesson 2.
Lesson 2 **Are pesticides related to the fish deaths?** **What is dissolved oxygen? Are they related to the fish deaths?**	Things we figure out: 1. Pesticides do not cause fish to die. 2. Fish are dying because of the lack of dissolved oxygen Content learning goals (CLG): 1. The amount of dissolved oxygen affects fish health. Epistemic learning goals (ELG): a. Models can also represent or help identify "black boxes": components or connections that are needed to complete the mechanism b. We can use evidence to rule some of the explanations out and narrow the field of possible explanations.	<u>Activities</u> - *MEME*- Revise group models and look at the resource library and how to support a model with evidence. - *Evidence*-- In small groups, students will engage with evidence set 2 on MEME. The evidence set is designed to support the "fish are missing something they need" model, and in particular the evidence will suggest they are missing dissolved oxygen they need to breathe. They also will learn that pesticides are not the factor that leads fish to die. The evidence set includes: - E2.1: Water quality report - A table showing the results of the water quality check. - E2.2: Dissolved Oxygen in Tanks - A table showing the amount of dissolved oxygen in the tank water and fish health - E2.3: Dissolved Oxygen in Ponds - A bar graph showing the dissolved oxygen levels in Blue Pond across a time span of several months. - *Evidence discussion*- Why it's important to describe evidence and how to do so using MEME. - *Modeling*- In small groups students revise their MEME models based on the new evidence. They are expected to rule out pesticides from the model and add dissolved oxygen, and link the evidence (above) to the model. - *Graphing*- Students will study the features of graphs to be able to read the graphs in MEME.

	c. Thoughtful peer critique and uptake of critique make models better.	- *Good comments discussion*- Discuss how to make a good comment. Students will be given some comment examples and discuss whether they are helpful and why. - *Gallery walk* (Part I) -- Using a virtual gallery walk format student groups will use MEME to review models of other groups and provide comments based on the model criteria. Expectations, model preparation, criteria, and comments. - *Class discussion-- what we figured out*-- Class discussion and documentation of what we figured out and of the scientific principles (CLG). We figured out that pesticides are not the reason for fish deaths. We also figured out that fish are dying from lack of dissolved oxygen. - *Revisit DQ*-- This raises a question: What is causing the lack of dissolved oxygen? Why are there more algae?

Lesson 3
 	
Why are there more algae?
 	
Where are the nutrients coming from?
	Things we figure out:
	1. Algae are tiny plants that live in water.
	2. Nutrients help algae grow. Fertilizer has nutrients.
	
	Content learning goals (CLG)
	1. All plants (including algae) need dissolved air and nutrients to grow and survive.
	
	Epistemic learning goals (ELG):
	a. Carefully aligning evidence with models makes models better.
	b. Some parts of the model we may be certain about and others we may be less certain (due to inconclusive evidence)
	c. Thoughtful peer critique and uptake of critique makes models better.
		<u>Activities</u>
		- *Class discussion*- overview and instructions
		- *Gallery walk* (Part II)-- As a class, students will discuss how to respond to peer feedback properly. In small groups, students will revise their MEME models based on the comments from the gallery walk.
		- *Evidence*-- In small groups, students will engage with evidence set 3, to understand that algae use up dissolved oxygen and nutrients can help algae grow.
		  - E3.1 Algae and oxygen- Report showing algae need oxygen and nutrients to grow.
		  - E3.2: Report on algae growth- A line graph showing the amount of algae in Blue Pond across a time span of several months.
		- *Evidence discussion*- discuss what they learned from the evidence, how they should change their model based on new evidence, and what evidence they want to add to the MEME library.
		- *Modeling*- In small groups students revise their MEME models based on the new evidence.
		- *Class discussion- what we figured out*- Class discussion and documentation of what we figured out and of scientific principles (CLG). We know algae need dissolved oxygen and nutrients to grow, and the heavy rainfall washes the fertilizer that has nutrients into the pond, thus causing algal bloom.

		- *Revisit DQ*-- This raises questions: what are algal blooms doing? How do they affect Dead Zones?
Lesson 4 **What are algal blooms doing?** **What are DeadZones?** **What happens to farms without fertilizer?**	Things we figure out: 1. Fish are dying because of suffocation. 2. Using and Not using fertilizer can cause different problems for the environment, and for the farmers and food. 3. This phenomenon also occurs in other locations. Content learning goals (CLG) 1. Fertilizer helps plants grow. 2. Excess nutrients runoff leads to algal blooms. Epistemic learning goals (ELG): a. Ideally, our models will have evidence to support all the parts, and we acknowledge where there are parts with little or no evidence. b. Iterative revision can make models better. c. Thoughtful peer critique and uptake of critique makes models better.	<u>Activities</u> - *Class discussion*- Review what students know about algae and nutrients and what they still don't know. - *Evidence*- In small groups, students will engage with evidence set 4 to confirm that fish are dying because of suffocation (ruling out other guesses), and that nutrients can cause algal blooms, which have led to current deadzones in the Gulf of Mexico; and not using fertilizer also causes other problems for farmers and food. - E4:1: Fish Autopsy Report- A table to show autopsy results of ten fish taken from blue pond. - E4.2: Algal Blooms and Deadzones - Report to show the effects of nutrients on algae. - E4.3: Fertilizer and Farm- A bar graph to show the comparison of crops harvested based on fertilizer used. - *Evidence discussion*- discuss what they learned from the evidence, how they should change their model based on new evidence. - *Modeling*- In small groups students revise their MEME models based on the new evidence and the criteria. - *Gallery walk* (Part I)-- Student groups will use MEME to review models of other groups and give critique based on the model criteria. Expectations, model preparation, criteria, and comments. - *Class discussion-- what we figured out*-- Class discussion and documentation of what we figured out and of scientific principles (CLG). We know fish are dying of suffocation, deadzones are caused by lack of dissolved oxygen, which is taken up by the overgrowth of algae, and the use (and not use) of fertilizer can cause different problems. - *Revisit DQ*-- This raises questions about how humans impact the environment in terms of using fertilizer. Where else does this happen? Is this common? Can this be solved?
Lesson 5	Things we figure out:	<u>Activities</u>

What are DeadZones?
 	
What happens to farms without fertilizer?
	1. Using and Not using fertilizer can cause different problems for the environment, and for the farmers and food.
	2. This phenomenon also occurs in other locations.
	
	Content learning goals (CLG)
	1. Fertilizer helps plants grow.
	2. Excess nutrients runoff leads to algal blooms.
	
	Epistemic learning goals (ELG):
	a. Ideally, our models will have evidence to support all the parts, and we acknowledge where there are parts with little or no evidence.
	b. Iterative revision can make models better.
	c. Thoughtful peer critique and uptake of critique makes models better.
		- *Class discussion*-- Review what students know about nutrients and fertilizer, and what they still don't know.
		- As a class, students will again discuss how to respond to peer critique properly, and share some good comments they received from previous rounds of gallery walk.
		- *Gallery walk* (Part I & II)-- In small groups, students will first give more critiques to their peer models, and then revise their MEME models based on peer comments.
		- *Evidence*- In small groups, students will review evidence set 4.
		  - E4.2: Algal Blooms and Deadzones - Report to show the effects of nutrients on algae.
		  - E4.3: Fertilizer and Farm- A bar graph to show the comparison of crops harvested based on fertilizer used.
		- *Evidence discussion*- students will further discuss what they learned from each evidence and how they should change their model based on the evidence.
		- *Modeling*- In small groups students revise their MEME models based on the evidence and the criteria.

Lesson 6 **How can we help Blue Pond become healthy?**	Things we figure out: 1. Identify strategies to solve this problem, like reducing fertilizer and airing the pond. 2. This phenomenon also occurs in other locations. Content learning goals (CLG):	<u>Activities</u> - *Class discussion*-- Read the letter from Fresh Org, which asks students to build a model to represent the global problem–Dead Zones. - *Building a consensus model*-- As a class, develop a consensus model that can be publically shared and captures our understanding. Discuss which parts of this model are supported by evidence, which parts we are certain about (because of lots of supporting evidence) and which we are less sure about; what other questions we still have. - *Class discussion - Brainstorming*-- As a class, we will discuss possible solutions to help the blue pond become healthy.

	1. We can use science ideas to solve problems and protect the Earth's environment. Epistemic learning goals (ELG): a. Models can be generalized from one phenomenon (e.g. the pond) to others (ocean, reefs, other ponds). We can develop a model that is more abstract and can fit/explain many phenomena.	- *Drawing solutions*- Students will work in small groups, using pens to draw solutions they come up with on one paper. - *Sharing solutions* - Students will share their solutions and have a brief discussion.
Lesson 7 **How can we solve this problem?**	Things we figure out: 1. Identify more strategies to solve this problem. Content learning goals (CLG): 1. We can use science ideas to solve problems and protect the Earth's environment. Epistemic learning goals (ELG): a. Models can be generalized from one phenomenon (e.g. the pond) to others (ocean, reefs, other ponds). We can develop a model that is more abstract and can fit/explain many phenomena.	<u>Activities</u> - *Class discussion*-- Review what students have come up with the solutions and discuss their pros/cons of different solutions. - *Modeling*- Students will work in small groups to refine their models based on their drawings, to reflect the solutions of the problem. - *Group presentations*- Each group will present their final model.

Full standards:

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5-PS3-1. **Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.** [Clarification Statement: Examples of models could include diagrams, and flow charts.]

5-LS1-1. **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

5-LS2-1. **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** [Clarifcation Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Use models to describe phenomena. (5-PS3-1)
- Develop a model to describe phenomena. (5-LS2-1)

Engaging in Argument from Evidence

Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Support an argument with evidence, data, or a model. (5-LS1-1)

Connections to the Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Science explanations describe the mechanisms for natural events. (5-LS2-1)

Disciplinary Core Ideas

PS3.D: Energy in Chemical Processes and Everyday Life

- The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms

- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary to 5-PS3-1)*
- Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

LS2.A: Interdependent Relationships in Ecosystems

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions. (5-LS2-1)

Energy and Matter

- Matter is transported into, out of, and within systems. (5-LS1-1)
- Energy can be transferred in various ways and between objects. (5-PS3-1)

https://www.nextgenscience.org/topic-arrangement/5matter-and-energy-organisms-and-ecosystems

5-ESS3-1. **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K- 12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model using an example to describe a scientific principle. (5-ESS2-1)

Using Mathematics and Computational Thinking
Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.

- Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.

- Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

ESS2.C: The Roles of Water in Earth's Surface Processes

- Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

ESS3.C: Human Impacts on Earth Systems

- Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)

Crosscutting Concepts

Scale, Proportion, and Quantity

- Standard units are used to measure and describe physical quantities such as weight and volume. (5-ESS2-2)

Systems and System Models

- A system can be described in terms of its components and their interactions. (5-ESS2-1), (5-ESS3-1)

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World.

- Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

https://www.nextgenscience.org/topic-arrangement/5earth%E2%80%99s-systems