Scope and Sequence: "Matter"

Unit Learning Goal: We can use our understanding of the particulate nature of matter and properties of matter to explain the world around us.			
Unit Central Question: How can we figure out what was mixed with pond water that could have changed the water?			
Anchoring Phenomenon: A healthy pond near a school has changed, and students see that there are a few dead fish in the pond.			
Lesson	**Focus question(s)**	**Main learning goal**	**Science content storyline**
1	What is changing in the water that is causing the death of living things, and how can we, as scientists, investigate the water?	Scientists make observations and ask testable questions to study water.	The phenomenon of a local pond that has dead things in the water suggests that something has changed in the water. Students begin to investigate the water by making observations and asking testable questions.
2	What might be in the water that could have killed the animals? What can we observe about each of those dangerous materials?	Matter has many different properties that can be observed. Some matter seems to disappear when added to water, but the matter is still inside the water.	Certain properties of matter can be directly observed. Mixing materials with water allows additional properties to be measured. Properties are any traits of a material that can be measured. Directly observable properties include state of matter, grain size, and color, among others. When matter is mixed together, mass is conserved even when matter seems to vanish.
3	What might be in the water that could have killed the animals? What can we observe about each of those dangerous materials?	Different materials have different identifiable properties. Some matter seems to disappear when added to water, but the matter is still there. The matter in the water-pollutant mixture is made of small particles too small to be seen.	Some properties that can be tested when materials are mixed with water include electrical conductivity, turbidity, pH, and solubility. Solubility measures a material's ability to dissolve into a solvent (usually water). The matter in the water-pollutant mixture is made of small particles too small to be seen.
4	What factors affect how quickly soluble solids dissolve into water?	There are variables that affect how easily new matter will dissolve into the water, such as water temperature, particle size, and stirring.	There are variables that affect how easily new matter will dissolve into water. Increasing the temperature of the water will speed up how fast something dissolves. Decreasing the temperature slows it down. Smaller particles dissolve faster than larger particles. Stirring the mixture will speed up how fast something dissolves.

5	How can we identify the pollutants in the pond water?	Properties of matter are used to identify substances.	Properties of matter are used to identify substances.
6	Can we get the water to be safe again?	Some pollutant-water mixtures can be separated by evaporation where the water evaporates and the other matter is left behind. Matter is conserved during evaporation. Gas is matter that is made of particles too small to be seen.	We can change the phase of water from liquid to gas and back to liquid. When water changes from liquid to gas, the salt or detergent stays behind, leaving pure water when it changes to liquid again. Gas is matter. Models can be used to show that matter, including gas, is made of particles too small to be seen. Matter is conserved through phase change.
7	How did the pollutants get into the pond in the first place?	Models can be used to describe natural objects from the very small to the immensely large. Models can explain interactions in systems. The particulate nature of matter and properties of matter can help us explain much of the world around us.	Properties of certain types of matter (pollutants) cause them to be problematic in water systems. Pollutants (matter) that are soluble can enter waterways and travel some distance. We can scale up our model to show how pollutants and water travel in the larger system around the school and the pond. We can use our understanding of the particulate nature of matter and properties of matter to predict and explain what pollutant is in water.

Fifth Grade "Matter"
Relevant Standards

<table>
<tr><th colspan="2">NGSS 5th grade</th><th colspan="2">Tennessee Standards</th></tr>
<tr><td>PEs</td><td>SEPs</td><td colspan="2">Earth Science (ESS)</td></tr>
<tr><td rowspan="2">5-PS1-1: Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2: Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

5-PS1-3: Make observations and measurements to identify materials based on their properties.</td><td>Developing and Using Models
• Develop a model to describe phenomena.</td><td rowspan="2">5.PS1: Matter and Its Interactions</td><td>• Analyze and interpret data from observations and measurements of the physical properties of matter to explain phase changes between a solid, liquid, or gas.</td></tr>
<tr><td>Planning and Carrying Out Investigations
• Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials is considered.
• Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.</td><td>• Analyze and interpret data to show that the amount of matter is conserved even when it changes form, including transitions where matter seems to vanish.</td></tr>
</table>

		Analyzing and Interpreting Data • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.		
		Using Mathematics and Computational Thinking • Measure and graph quantities such as weight to address science and engineering questions and problems.		• Design a process to measure how different variables (temperature, particle size, stirring) affect the rate of dissolving solids into liquids.
		Constructing Explanations and Designing Solutions • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.		• Evaluate the results of an experiment to determine whether the mixing of two or more substances result in a change of properties.
DCIs				
PS1.A Structure and Properties of Matter	• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model that shows gases are made from matter particles that are too small to see and that are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. • Measurements of a variety of properties can be			

	used to identify materials.		
CCC			
Cause and Effect ● Cause and effect relationships are routinely identified, tested, and used to explain change. **Scale, Proportion, and Quantity** ● Natural objects exist from the very small to the immensely large. ● Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.			

“Matter” Handouts and Materials

Materials

Item	Lesson							Quantity, descriptor, notes
	1	2	3	4	5	6	7	
Reusable materials								
Communicating in Scientific Ways poster	X	X	X	X	X	X	X	1 color poster per classroom
Water bottle	X	X	X	X	X	X		1.5 L each, 3 per class. These can be used for mixing the initial samples and then for pouring water for investigations in later lessons.
4-8 oz, closed container	X	X	X		X			2 per group for water samples
Hand lens	X	X	X	X	X	X		1 per group
Kitchen scale		X	X	X				Used for conservation of matter activity. Groups may use this for their investigations.
Plastic container with lids		X	X	X	X			plastic container with lid, 10 per class, 2 for each pollutant for storing pollutants for the materials station
Thermometer			X	X				1 per class, to check temperature of water
Coffee filter dripper cup		X	X	X	X			2 per class
Syringe, 60 mL		X						1 per group
Syringe, 10 mL		X						4 per class for measuring liquid pollutants
Buzzer			X		X	X		1 per class for circuit
Alligator clips			X		X	X		3 clips
AA battery holder			X		X	X		Needs to hold 4 batteries
Plastic food tray	X	X	X	X	X	X		1 per group
Petri dish		X			X			10 per class, can be washed between uses
Secchi disk			X		X			1 per group
Measuring spoon		X	X	X	X			10 mL, 6 per class
Plastic cup		X	X	X	X			30 per class
Consumable materials: all per class								

Kosher salt (with large crystals)				X				
Ice melt				X				1 snack-sized zip-close plastic bag
Miracle-Gro fertilizer		X	X		X			1 8-oz package
Food coloring (not gel -- red, blue, green, yellow)		X	X	X				
Iodized salt	X	X	X	X	X			2 cans
Hand soap	X	X	X		X			Milky-colored, 2 7.5-oz containers
Dirt		X	X					1-quart-sized zip-close plastic bag
Motor oil		X	X					1 quart
Stirring sticks		X	X	X	X			100
AA batteries			X	X	X	X		
Coffee filters		X	X	X	X			30, #2 paper cone filters
pH strips			X		X			80, cut in halves or thirds vertically

Student Handouts

Item	Lesson							Notes
	1	**2**	**3**	**4**	**5**	**6**	**7**	
HO1.1 *Communicating in Scientific Ways*	X	X	X	X	X	X	X	optional, 1 per student, color
Lesson 1_HO1 *Initial Models*	X							1 per student
Lesson 2_HO1 *Data Table*		X					X	1 per student
Lesson 3_HO1 *Data Table*			X					1 per student
Lesson 6_HO1_*Distillation with Zooms*						X		1 per student, color
Lesson 7_HO1_*Pond Water Data*							X	1 per student

Teacher Resources

Item	**Lesson**							**Notes**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
TE1.1 Observing Waterways: Matter Lesson 1	X							Video; available in Video Resources folder on Google drive
TE2.1 What could be in the water?: Matter Lesson 2		X					X	video; available in Video Resources folder on Google drive

TE3.1 Testing Water: Matter Lesson 3			**X**					video; available in Video Resources folder on Google drive
TE6.1 Distillation: Matter Lesson 6						**X**		video; available in Video Resources folder on Google drive

General Supplies

Item	**Lesson**							**Notes**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
Student notebooks	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Chart paper, markers, painter's tape	**X**	**X**	**X**	**X**	**X**			
Markers			**X**	**X**	**X**			Bulk markers; 1 set per group
Plain white paper, 8.5" × 11"			**X**					2 pieces per group
Transparent tape			**X**					1 roll per group. A less desirable alternative: the teacher can distribute a length of tape to each group.
Fine-point markers for students (dark colors: black or dark blue)	**X**	**X**	**X**	**X**	**X**			These are used by students to write questions they have on sticky notes to place on the DQB. They need to be markers so that the words are visible to all.
Sticky notes	**X**	**X**	**X**	**X**	**X**			Students may use these in each lesson to add questions to the DQB and for other tasks. The 3" × 3" ones are fine. Two colors are needed for Lesson 5.

Using an Anchoring Phenomenon
Lesson 1 in a STeLLA Lesson Set

What is an anchoring phenomenon?
An anchoring phenomenon ("anchor") is a naturally occurring event that causes one to wonder and ask questions. An effective anchor requires an explanation involving the application of multiple science concepts (core ideas), crosscutting concepts, and science or engineering practices--the three dimensions of science learning described by the Next Generation Science Standards (NGSS). The anchor motivates the learning for several if not all lessons in a lesson set. For an engineering-focused lesson, the anchor could be a meaningful design problem. These anchoring phenomena are used to draw students into the storyline by presenting the natural challenge of explaining something or solving a problem grounded in the real world.

What is an anchor lesson, and what is its purpose?
The anchor lesson is used to kick off a lesson set and drive student motivation to learn throughout the lesson set. The purpose of the anchor lesson is to build a shared mission for a learning community to figure out phenomena or solve design problems. More specifically, the anchor lesson serves to ground student learning in a common experience and then use that experience to elicit and feed student curiosity, which will drive learning throughout the lesson set. The anchor lesson also serves as a critical place to elicit students' initial ideas, which are important for both for the students and the teacher. For teachers, this is an opportunity for pre-assessment.

The anchor lesson
- motivates a need for students to know more than they already know.
- sparks student interest and curiosity.
- creates a sense of puzzlement and sets students up for a "need to know" more to either explain a phenomenon, design a solution, or solve a challenge.
- allows the teacher to get a sense of what students already understand about the phenomenon that can be leveraged throughout the unit.
- elicits questions that the students want to investigate and answer throughout the lesson set.

How do students typically represent their thinking as part of the lesson?
The anchor lesson pushes students to represent their initial thinking by writing, drawing, and/or sharing their own initial ideas, models, explanations, or design solutions. These might be represented in their science notebooks. In the anchor lesson, students also raise questions they have about the phenomenon.

What are the main learning goal and focus question for the anchor lesson?
As the launching point for the lesson set, the purpose of the anchor lesson is unique. The anchor lesson is a full lesson designed to draw out students' initial ideas and questions about the phenomenon. Therefore, the main learning goal (MLG) used by teachers and the focus question (FQ) that students will answer should reflect that there is not a specific science

concept that students should learn in the lesson (Strategies A and B in the Science Content Storyline Lens further describe MLG and FQ). Main learning goals for subsequent lessons are the science ideas students should learn to build the science content storyline of the lesson set. These later lessons are designed in a way that students work with their initial ideas to figure out important science ideas or design solutions in the science content storyline of the lesson set.

Typical learning goals and focus questions for the anchor lesson will be similar to this structure:

MLG: Students have many ideas and questions about *(insert overarching science concept or the phenomenon or problem)* that they can work with to figure out a more scientifically accurate way of thinking.

FQ: What do we know and wonder about *(insert overarching science concept or phenomenon or problem)*?

Typical Design Elements of the Anchor Lesson

Introduce Communicating in Scientific Ways

The anchor lesson will introduce STeLLA Strategy 4, Communicating in Scientific Ways (CSW), to students, if this is new to them. If students have used CSW before, they will find opportunity in the anchor lesson to reacquaint themselves with the strategy and to practice using the sentence starters to communicate with the teacher and their peers. Teachers are asked to display the CSW poster in the room and give students a copy of the poster to attach to their notebook. Sentence starters are introduced or used with students for select rows of the CSW poster the first time students encounter CSW in the lesson. Appropriate rows of the CSW poster to use for the anchor lesson are suggested in the Elements below.

Element 1: Explore the Anchoring Phenomenon

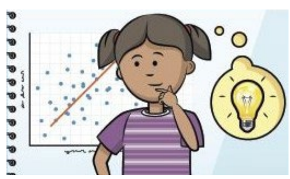
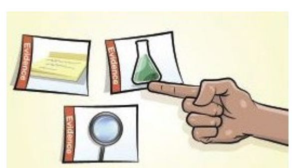
Students are introduced to a puzzling phenomenon that they experience and explore in some way. In this initial exploration, the question the class focuses on is "What do we notice?" For example, students might make observations, look for patterns, or create a timeline of events that occurred. The purpose of this element is for students to recognize the interesting events going on and to publicly, as a learning community, acknowledge aspects of the phenomenon that requires explanation. Students also access their prior knowledge related to the phenomenon that might be useful in exploring and explaining the phenomenon.

Appropriate CSW sentence starters to suggest		
2. Observe.		I see …. I noticed …. I measured ….

Element 2: Attempt to Make Sense

In the "making sense" element, students try to come up with an initial explanation, model, or some other reasoning to explain their thinking about why or how the phenomenon under investigation is happening. The point of this element in the anchor lesson is for students to voice their initial ideas about the phenomenon, no matter how inaccurate or far-fetched they may be. The purpose is to lay a foundation to leverage student ideas and student thinking for the investigations they will conduct throughout the lesson set to help them figure out the scientific explanation or design a solution for a problem. By trying to make sense of the phenomenon, students generate ideas that lead to questions and new ideas that they will want to investigate.

It's important that each student tries individually to make sense of the phenomenon or problem and then go public with his or her ideas. Diversity of ideas and ways of making sense is very productive and exciting! It helps create the sense that we are not all on the same page and that there are things here that beg to be figured out. The role of the teacher in this part of the process is twofold: (1) to help students get their thinking down on the page, regardless of whether it's right or wrong, and (2) to encourage students to come up with their initial ideas for a mechanistic explanation about what's going on. Encourage students to go deeper if they think they know the answer. More likely than not, even students who use correct vocabulary to explain what they think is going on cannot really tell you what those words mean in a mechanistic way.

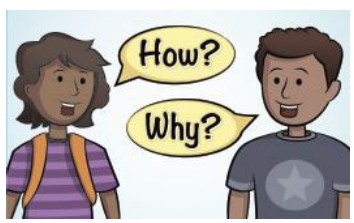
Appropriate CSW sentence starters to suggest		
4. Think of an idea that explains your data and observations		My idea is …. I predict ______ will happen because …. I think what causes this is …. I could draw a picture or diagram to show ….
5. Give evidence for your idea or claim.		My evidence is …. The reason I think that is …. I think it's true because ….
6. Listen to others' ideas and ask clarifying questions.		Are you saying that …? What do you mean when you say …? What is your evidence? Can you say more about …?
7. Agree or disagree with others' ideas; add onto someone else's ideas.		I agree/disagree with _____ because …. I want to add to what _______ said.

Element 3: Pose Questions to Resolve and Discuss Next Steps
In the third element, the class uses a Driving Question Board (DQB) to create a class list of student questions. These are questions that students have about the phenomenon or problem. Generally, answering these questions should help students figure out the mechanism behind the phenomenon, explain the phenomenon, or design a solution to a problem. What's unique about three-dimensional learning is the opportunity for students to be involved in the thought process and decision-making about what the class should be figuring out. It is important for each student to participate in generating a question to be explored and for those questions to be made public so that the class, as a whole, owns and drives their learning.

Connecting to the anchor in subsequent lessons
The class returns to DQB at the end of lessons as appropriate. Returning to the DQB is a way to link what students figured out in the current lesson (or questions on the DQB that they have answered) and what question makes sense to answer next (from those on the DQB or additional questions they add).

This is an example sequence of this element:

- The teacher asks, "What do we want **to know** next?"
    - Students write individual questions.
    - Students share questions aloud.
    - The class organizes the questions on the DQB.

Appropriate CSW sentence starters to suggest		
1. Ask why and how questions.		How come …? I wonder how …? I wonder why …? How do they know that …?

Element 4: Introduce the Unit Central Question as an Overarching Question from Their DQB

After student questions are posted on the DQB, the class helps the teacher organize the questions into categories. The teacher has the main learning goals and focus questions for the upcoming lessons in mind and, as appropriate, groups the DQB questions according to those focus questions. Students' questions won't always fit with the upcoming lesson sequence. They still belong on the DQB but remain as unanswered questions at the end of the lesson set. As you continue to work with new experiences in the lesson set, new questions will emerge that students can add to the DQB.

The unit central question should be one that most questions relate to in some way. Teachers introduce the unit central question and write it across the top of the DQB.

Adapted from Open SciEd Teacher Handbook.