ALL for Science™
Authentic Literacy and Language for Science

Baylor College of Medicine
CENTER FOR EDUCATIONAL OUTREACH

DAY 2: Is There Life in Mud?

MINI-LESSON

Teacher introduces the "Generating Questions" anchor chart and models how to generate quality inquiry questions.

SCIENCE INQUIRY CIRCLES

Teams are introduced to the Inquiry Charts they will use in their investigation of a method of food disposal.

GUIDED SCIENCE INVESTIGATIONS

Each team is provided a modified Winogradsky column for daily observation.

ABBREVIATED STANDARDS

- ELA and Reading TEKS: 5.13(A)
- CCSS: W.5.7
- NGSS: 5-LS1-1, LS2.B
- TEKS: 5.1(A)(E), 5.5(A)

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Literacy Strategy: Generating inquiry questions

Science Concept: Some microbes have an essential role as decomposers in the cycling of matter and flow of energy in an ecosystem.

Science and Literacy Connection: In their work, scientists ask questions and find answers to their questions through inquiry and investigations.

Mini-Lesson (15 minutes)

OVERVIEW

The vast majority of scientists' work revolves around asking questions and finding answers to those questions through inquiry and investigation. Very few elementary learners have been allowed or encouraged to ask questions within a standardized curriculum; however, it is important that learners not only be allowed and encouraged to ask questions but that they are taught how to ask questions that require scientific investigation to answer (we'll call those **quality** questions).

When given a chance to generate their research questions, many learners often ask known-answer questions (questions they can likely already answer) or "go Google it" questions (such as, "What is vermicomposting?"). While there is justification for these kinds of questions, they will not move learners into more complex understandings of the construct/phenomenon they are learning in science, nor will they help learners understand the kinds of questions scientists ask—questions that will **launch** a scientific investigation.

The types of questions we want learners to ask are those that come from a place of personal interest, that are aligned with the topic of study, and that are answerable after consulting multiple informational sources (text, audio, and video) and then comparing, contrasting, and synthesizing the information they gather across these sources. Learners' questions are the starting point for an investigation: they gather data from multiple texts.

One of the most difficult things to teach learners is how to ask questions that require multiple sources to answer (or at least to compare/contrast answers). Often, questions have to be "tweaked" once inquiry has begun because we sometimes don't yet know the true question we're asking until we see what others have asked/answered. It's important to keep this in mind and to support learners as they "find the right questions to ask" that build on their current knowledge about their topic and also contribute to the learning of their team and the class.

NOTE: You are encouraged to "think aloud" as you create the "Generating Inquiry Questions" anchor chart with your learners and move through this lesson (we call this "intentional instruction"), using the provided anchor chart as a model. Post the anchor chart for easy reference when completed and remind learners to refer to the anchor charts during inquiry circles.

MATERIALS

Teacher needs:

- chart paper
- marker(s)
- "Generating Questions" anchor chart as a model
- model Inquiry Chart

PROCEDURE

The *italicized statements* below offer suggested wording the teacher may choose to use in the lesson.

Tell what the strategy is (declarative knowledge)

1. *Today we're going to learn how to generate inquiry questions for your science inquiry circle project. Generating questions means asking questions that will guide your inquiry.*

Tell when and why to use the strategy (conditional knowledge)

1. *Generating questions is the same as "asking" questions. I generate questions at the beginning of every inquiry project I do.*
2. *This is an important strategy because the questions I generate (or ask) will guide my research and keep me focused as I read interesting and important information about my topic.*
3. *It is helpful to know what my team will do with the information we find after we complete our inquiry. This can help me ask questions that will help us achieve our goals at the end of the inquiry. At the end of this inquiry, each team will write a report about their chosen method of reducing food waste, how it has been used at other schools, and how it might be used at our school. As part of our report, we will need to explain what happens to the organic matter and stored energy in the food scraps. I can ask myself: What do we need to find out to explain all of these components?*

Tell how to use the strategy (procedural knowledge)

1. *The first thing I do is think about what I (and the others on my team) already know about my topic. It helps me to write down everything on a "What I know" chart.*
2. *Then I think about what my team will do at the end of our three-week unit: We will write a report about our chosen method of reducing food waste, how it has been used at other schools, and how it might be used at our school. As part of our report, we will need to explain what happens to the organic matter and stored energy in the food scraps.*
3. *I then think about all the things I'd like to know about my topic and the things I will need to know to write a report. I sometimes think about these words as starters to my questions:*
    - *Why . . .*
    - *How . . .*
    - *Under what conditions . . .*
    - *When . . .*

4. *Once I've brainstormed questions, I try to organize them, looking for the questions that are most important for me to answer and that are "quality" questions. Quality questions are those that (a) are neither too broad nor too narrow, (b) will contribute to my knowledge and the knowledge of others, and (c) are answerable.*

Model the Strategy

1. *First, I'll brainstorm everything I know about the methods of reducing food waste.* (Encourage learners to contribute to your brainstorming document.)

	What we know (about methods of reducing food waste)	**What we want to know (about methods of reducing food waste)**
	Food scraps can be composted, or left in a pile to rot Food scraps can be fed to animals like worms and pigs Uneaten but safe food can be shared and donated so that people can eat it later	

2. *Now, I'll think about the things I want to learn about my method of reducing food waste and what I will need to find out to write a report on this method.* (Encourage learners to contribute to your brainstorming document.)

	What we know (about methods of reducing food waste)	**What we want to know (about methods of reducing food waste)**
	Food scraps can be composted, or left in a pile to rot Food scraps can be fed to animals like worms and pigs Uneaten but safe food can be shared and donated so that people can eat it later	What happens to the organic matter in the food scraps when food is composted or fed to a living thing? What happens to the energy stored in the food scraps when food is composted or fed to a living thing?

Science Inquiry Circles (30 minutes)

OVERVIEW

Scientists identify inquiry questions and record their data in an organized manner. Today teams are introduced to the Inquiry Charts they will use as they investigate methods of reducing food waste. You may want to model how to use the Inquiry Chart. The blank Inquiry Chart provided below can be used to create a larger version on chart paper so that it can be seen easily by the whole class, or it can be projected onto a large screen.

Blank Sample Inquiry Chart

Our Inquiry Questions →	**Inquiry Question 1**	**Inquiry Question 2**	**Inquiry Question 3**	**Inquiry Question 4**	**Other Interesting Facts**
What we know →					
Source 1 Title: Author: Publisher: Date: URL (for online):					
Source 2 Title: Author: Publisher: Date: URL (for online):					
Source 3 Title: Author: Publisher: Date: URL (for online):					
Source 4 Title: Author: Publisher: Date: URL (for online):					

A true inquiry allows learners to develop their inquiry questions. The resources compiled for this inquiry are focused on how schools around the U.S. are transferring organic matter (food scraps) from the school to somewhere else so that the stored energy in the food scraps can be used by other living things. At this point, each team has chosen (or been assigned) one way to transfer energy from food scraps to other living things: composting food scraps, feeding food scraps to worms (vermicomposting), feeding food scraps to pigs, or sharing and donating leftover food. The teams will generate questions about their food disposal method and how schools reduce their food waste using this method. Learners might generate questions about how food decomposes, what the school site does with food, what

happens to the food after it leaves the school, and how the particular method works. Then, the class will come together to agree upon 3–5 questions that all groups can answer about their method.

Teachers will need to support students in translating their specific questions into broad questions that all groups can answer. For example, the vermicomposting group might wonder, "What happens to food scraps after worms eat them?" The teacher can guide the class toward a version of this question that all groups can explore (e.g., "What happens to food scraps after a living thing uses them to get energy?") while encouraging learners to be specific about what kind of living thing is getting energy from the food scraps in the method they are researching. Throughout the unit, learners may develop additional questions that can be added to the Inquiry Charts.

MATERIALS

Each team needs:

- a team Inquiry Chart on 11" x 17" paper or butcher paper (**created by the teacher; see model above**); teachers may also choose to create inquiry charts digitally in a sharable platform like Google Docs
- index cards or sticky notes for generating questions
- pencils

Teacher needs:

- blank sample Inquiry Chart

NOTE: If you feel your learners need more working space, you might recreate these charts on large pieces of chart or butcher paper, but be sure the size is easy for the learners to use and manageable for storage when teams are not working on them. **If your learners have not used an Inquiry Chart before, it is suggested that you have each team's Inquiry Chart created before starting the lesson.** If Inquiry Charts are familiar to your learners, you might give them the option to create their Inquiry Chart.

PROCEDURE

The *italicized statements* below offer suggested wording the teacher may choose to use in the lesson.

Before Inquiry Circles (5 min)

1. *Now we will get into our Inquiry Circle teams.* (Help learners find their assigned teams. Ask Equipment Directors to gather the team Inquiry Chart and writing utensils. Once all items have been distributed, the teacher will tell each team which food disposal method they have been assigned.)
2. *You will work in the same team every day during inquiry circles and the science investigations. Now that you know which method of reducing food waste you have been assigned, please write it in the top corner of the Inquiry Chart, along with each team member's name.*
3. *Today we are going to start a guided inquiry. You can see along the top of the Inquiry Chart that there are four column headers where you will write your inquiry questions, as well as a column for other interesting facts.*

During Inquiry Circles (20 minutes)

1. *We have a variety of resources available where you can find information about how matter and energy are transferred in your method of reducing food waste*. *In your teams, you'll start by*

thinking about our shared questions (from the mini-lesson), and then your team will generate more questions about its assigned method of reducing food waste in schools.

- *In addition to what we brainstormed in the mini-lesson, what would you like to know about your chosen method of reducing food waste? About how matter and energy are transferred in your method of reducing food waste? Generate some questions with your team and write them on index cards or sticky notes.*
- *After you have written down all your questions, work with your team to choose 3–5 "quality" questions.* (Remind learners that quality questions are those that are neither too broad nor too narrow, will contribute to their knowledge and the knowledge of others, and are answerable.)

2. *Now that we have selected our "quality" questions, we are going to come together as a class and agree on some shared questions that we can all answer.* Invite teams to share their questions and combine similar questions when possible. (Guide the teams toward 3–5 shared questions. This might be an opportunity to remind learners about the report they will be writing and further narrow down questions to those that will be most helpful in writing their reports.)
3. *Now that we have agreed on our shared questions, take a moment to write these questions in the header spaces on your Inquiry Charts. (*Point learners to the correct spaces on the Inquiry Charts.)
4. *Take a few moments to discuss **what you already know** about your inquiry topic. The Lab Directors will lead the discussion. Be sure everyone has a chance to share. Do not write anything on your Inquiry Chart just yet.* (While teams are working, walk around the room and assist as needed.)
5. *Now, everyone should assist the Data Scientist in recording in the correct column what the team already knows. For example, if the team already knows something related to one of the inquiry questions, write it in the column below that question. If the team knows something that doesn't fit with these inquiry questions, record it in the "Other Interesting Facts" column.* (While teams are working, walk around the room and assist as needed.)

After Inquiry Circles (5 minutes)

1. *As we conclude our inquiry circles for today, each team will have a chance to share what they already know about methods of reducing food waste, as well as what the team accomplished and learned. The Lab Director will lead the discussion.* (You may want to post or project a guiding list of questions for learners to use during their team discussions. The following questions may be used, though you may add any of your own based on your class's needs: *What did the team already know? What problems did the team encounter? How did the team resolve those problems? What new questions came up during the discussion?*)
2. *The Data Scientists will now share with the entire class either something their team learned about its food-disposal method or any new questions that came up.*
3. After all learners have shared, thank them for their hard work and point out any practices of scientists you observed. If you notice any problems in the teams during the lesson, take a moment to point them out, and explain your expectations for all future inquiry circles. Collect all Inquiry Charts or have learners put them in their normal classroom place for ongoing work so they can easily access them.

Guided Science Investigation (30–45 minutes)

OVERVIEW
Bottles of water and sediments are introduced to the class for observation.

GUIDING QUESTIONS
What do I see in this bottle? What do I think is happening in this bottle?

BACKGROUND INFORMATION FOR THE TEACHER
In the 1880s, scientist Sergei Winogradsky invented a simple device for studying soil microorganisms and the cycling of nutrients. The Winogradsky column consists of a transparent container filled with pond water and mud to simulate a naturally layered soil ecosystem and allow researchers to observe how a diverse range of microorganisms occupies different niches within an ecosystem.

Even though we can't see them, many species of microorganisms are present in soil, and some have an important role in the decomposition of organisms. Like plants and animals, microorganisms also have the same basic needs for water, nutrients, and energy.

In this unit, we are using a modified version of the Winogradsky column to demonstrate the key role of microorganisms in the cycling of matter and the transfer of energy within soil. The bottles you have prepared will be the focus of daily observations during the science investigations. They will allow learners to observe real-time changes as layers are formed in the bottles—evidence that microbes, specifically bacteria, are alive and reproducing. But where are they getting the energy to reproduce and stay alive?

NOTE: We ask that the teacher not reveal how the bottles were made or what they contain until Day 7, allowing learners to make inferences about what is happening. As the unit progresses, connections back to the microbial activity in the modified Winogradsky columns will be made.

DAILY OBSERVATIONS
Each day, teams will examine their bottles and record observations in their Investigation Journals. Observations can be made at any time of the day.

SAFETY
Remind learners not to shake the columns or move them in a way that disturbs the layering.

MATERIALS
Each team member needs:

- Investigation Journal
- pencil
- colored pencils or crayons

Each team needs:

- 1 premade bottle
- hand lenses

Teacher needs:

- premade bottles (1 per team; see Before the Unit Begins section for instructions)
- lamp with bulb

SETUP

- Determine where the prepared bottles will be set up under the lamp to allow easy access for team observations. **Keep in mind that the bottles should not be shaken or moved in a way that will disturb the layering.**
- Prepare to assign teams a specific bottle to observe for the duration of the unit.
- Make hand lenses available for observations.

PROCEDURE

The *italicized statements* below offer suggested wording the teacher may choose to use in the lesson.

Engage

1. Gather the class where all can see one of the prepared bottles. Ask, *What do you see?* Accept their responses but offer no clarification or information at this point.

Explore

1. Explain that each team will be assigned its own bottle and that, beginning today, they will make daily observations about what they see, looking for any changes that may occur. Add that observations may be made at any time during the day as long as they record their observations.
2. **Explain that only the Equipment Directors will be responsible for moving the bottles to a table or desk for team observations. Model how to do this. Caution all team members not to shake or in any way disturb the contents of the bottles.**
3. Ask learners to open their Investigation Journals to page 2. Point out the different sections they will need to complete for each day they make observations, **including the date**.
4. Remind learners that they are working as a team. The Lead Scientists should encourage the sharing of ideas and questions; however, each team member should record their information in their own journals.
5. Allow adequate time for initial observations and discussions among team members.

Explain

1. When work is complete, ask the Data Scientists from each team to give a brief summary of their team's observations. What did the team see? What are their ideas about what might be in the bottles?
2. Ask if anyone else wants to add their thoughts to the conversation. Respond to them with open ended questions, such as, *What made you think that? Can you describe . . . ?*
3. Tell the class that change may be slow in the bottles but that it's important to document what they see every day.

Elaborate

1. Write this statement on the whiteboard: *Decomposition is the breaking down of certain types of matter, including dead organisms like plants and animals, that eventually become part of the soil.*

2. Explain that throughout this unit, learners will explore how the process of decomposition cycles matter and transfers energy in ecosystems.

Evaluate

1. Learners will answer this question in their Investigations Journals: *What should we look for in our bottles that might be related to decomposition?*

Science Language

- **Decomposition** is the breaking down of certain types of matter, including dead organisms like plants and animals.
- **Observing** is carefully looking at something or someone to gather information.
- **Matter** is anything that takes up space and has weight. It can be in the form of a liquid, solid, or gas.
- **Energy** is the ability to do work or cause change and can be transferred through the interactions of organisms in an ecosystem.
- In nature, **cycling** refers to the recurring flow of matter and energy through ecosystems.

Expanded Standards

English Language Arts and Reading TEKS

5.13(A) Generate and clarify questions on a topic for formal and informal inquiry.

CCSS

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

NGSS

5-LS1-1 Support an argument with evidence, data or a model. **LS2B** Matter cycles between the air, water, 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.

Science TEKS

5.1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations; **(E)** collect observations and measurements as evidence. **5.5 (A)** identify and use patterns to explain scientific phenomena or to design solutions.