Professional Learning Materials

Assessing for Learning

Many people think of assessment as giving tests after instruction, but assessment for learning is much richer than that. Assessments are information-gathering tools. They might be learning activities, discussions, writing prompts, projects, or even tests that are all part of student learning experiences. This session focuses on embedded formative assessment practices—any activity that provides evidence of student learning that can be used to quickly inform instruction and promote further learning. When instructors make systematic observations of learners, gather and analyze student work, listen to student discussions, and ask specific questions, assessment becomes indistinguishable from good teaching because it is embedded within instruction.

Regular assessment should be part of any instructional experience. By assessing students at selected points during instruction, an instructor can get an idea of the group's and each individual's level of understanding, misconceptions, and interests. This ongoing feedback helps instructors adjust field experiences to best address the strengths and needs of their learners. It also helps learners to be more reflective about their own learning. Without regular assessment, instructors can only know what they are teaching but not what their students are learning!

The first two-thirds of the session focuses on assessments that can be done on-the-fly, during instruction, and that should be part of field instructors' routine instructional habits. The final part of the session dives deeper into discussing and analyzing written responses from students, which are assessment strategies that take more time and effort from instructors. Engaging in this deeper process, even occasionally, can enrich instructors' understandings about student ideas and learning. Both parts of the session build instructors' understanding of how students learn and express their ideas and can work well presented as two sessions, instead of all at once.

The goals for this session are:

- **Participants will experience a variety of assessment strategies for field instruction.**
- **Participants will recognize the challenge of understanding what students have learned.**
- **Participants will discuss how to choose the best type of assessment for different purposes.**
- **Participants will learn about a variety of assessment practices that support student learning and improve instruction.**

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) is a program of The Lawrence Hall of Science at the University of California, Berkeley, that provides professional learning sessions, student activities, and supporting resources for outdoor science program leaders and their staff. The goal is to infuse outdoor science programs everywhere with research-based approaches and tools to science teaching and learning that help them continually improve their programs.

www.beetlesproject.org

The Lawrence Hall of Science is the public science center of the University of California, Berkeley. *www.lawrencehallofscience.org*

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California: YMCA Camp Campbell, Rancho El Chorro Outdoor School, Blue Sky Meadow of Las Angeles County Outdoor Science School, YMCA Point Bonita, Walker Creek Ranch, Santa Cruz County Outdoor Science School, Foothill Horizons Outdoor School, Exploring New Horizons Outdoor Schools, Sierra Nevada Journey's School, San Joaquin Outdoor Education, YMCA Camp Arroyo, Shady Creek Outdoor School, San Mateo Outdoor Education, Walden West Outdoor School, Westminster Woods.

Other locations: Balarat Outdoor Education, CO; Barrier Island Environmental Education Center, SC; Chincoteague Bay Field Station, VA; Eagle Bluff Environmental Learning Center, MN; Great Smokey Mountain Institute at Tremont, TN; Wellfleet Bay Wildlife Sanctuary-Mass Audubon, MA; Mountain Trail Outdoor School, NC; NatureBridge, multiple locations; Nature's Classroom, multiple locations; North Cascade Institute Mountain School, WA; Northbay, MD; Outdoor Education Center at Camp Olympia, TX; The Ecology School, ME; UWSP Treehaven, WI; Wolf Ridge Environmental Learning Center, MN; YMCA Camp Mason Outdoor Center, NJ; and YMCA Erdman, HI.

Photos: Pages 1 and 3 by Kevin Beals. *Icons*: Backpack by Rémy Médard; Beetle by Ola Möller; Cut by Nathan Thomson; Outside by Petr Holusa; Park by Antar Walker; &Time by Wayne Middleton all from The Noun Project.

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To contact BEETLES™, email beetles@berkeley.edu

Assessing for Learning

Contents

TEACHING ABOUT TEACHING

This session has been designed to "practice what we preach" and is set up to reflect a learning-cycle approach to instruction. In this way, participants will experience a version of the learning cycle instructional model while they learn about assessing for learning. It's important to structure the session so there are opportunities for participants to experience each phase of the model for themselves. Resist the temptation to dole out too much information too early. Simply telling instructors about assessment goes against the whole idea—participants will gain more from engaging in science practices, reflecting on the nature of science, and thinking about how to apply this to their instruction.

PRESENTATION OPTION

Want to spend more time outdoors than in? This whole session can be done outdoors. Some slides can be skipped outdoors, but other text is important. You and your co-presenter can take turns writing text from slides on whiteboards or chart paper or printing out some slides as large as possible. You may want to put the printed slides in plastic page protectors.

TIMING TIP

Keep things moving. The prompts provided in the session are purposefully designed to generate productive and interesting conversations. However, interesting discussions can make it challenging to stay within the estimated time frame. You may need to gently limit some of the discussion and then pick up on the topic at another time, perhaps after staff has had some experience with applying the teaching strategies.

SESSION OVERVIEW

	Assessing for Learning	Activity Locations	Estimated Time
Invitation	**Introducing Assessing for Learning** Participants are introduced to assessment as gathering evidence of learning to inform instruction and promote further learning.		10 minutes
Exploration	**Modeling Assessment Strategies** The presenter(s) models practical ways to assess students during model student field activities: *Mind Pie*, *Decomposition Mission*, *and Walk & Talk*.		70 minutes
Concept Invention	**Debriefing Embedded Assessment Opportunities in *Decomposition Mission*** Participants brainstorm and discuss opportunities for assessment in the modeled activities. They discuss individual vs. group assessments, oral vs. written, and the importance of students explaining their thinking in their own words. Participants learn the value of performance-based assessment.		15 minutes
	Planning for Assessment Participants learn the importance of planning learning goals, what evidence to look for, how to collect evidence, when assessment should happen, when to use group versus individual assessment, and when to use a performance task. They discuss the value of broad questions and written prompts in assessment. They also discuss whether to use assessments before, during, or after instruction. They receive an *Assessing for Learning* handout that summarizes best practices in assessment.		20 minutes
Application	**Looking Closely at Student Work** Participants look at an example of a written assessment: student responses to a prompt about decomposition. Working in small groups, participants use a structured process to examine and discuss student work and then discuss next steps for teaching.		50 minutes
	Discussing How to Use Evidence of Student Learning to Improve Instruction Participants discuss ideas for adjusting instruction based on evidence from student work. They learn hints for writing productive assessment prompts. They also learn the importance of using student responses to evaluate their assessment prompts.		10 minutes
Reflection	**Wrapping-Up the Session** Major points of the session are reviewed, and participants reflect on how they might apply assessment to their instruction.		10 minutes
	TOTAL	**3 hrs, 5 min.**	**185 minutes**

PREPARATION

Before the day of the session:

1. **Prepare to present.** Choose who will present each part of the session. (See below for information on model student activities.) Consider including staff who have already experienced the session. Read through the session write-up, slides, handouts, sidebars, and background section (starting on page 54) to prepare. The more each presenter is able to "own" the session, the better the presentation will be. Write notes on a printed version of the session, or whatever works best. If you choose to present the whole session outdoors, make large copies of slides, or print half-page copies for you to refer to the information, or write the information on whiteboards. Modeling of student activities, especially Decomposition Mission, should be done outdoors.
2. **Set up projection system/review multimedia.** Set up and test the projection system to be sure participants will be able to see items projected during the session.
3. **Read and familiarize yourself with the *Mind Pie* and *Decomposition Mission* student activity guides; assess your ability to lead the activities.** Read and familiarize yourself with *Mind Pie* and *Decomposition Mission* student activity guides; assess your ability to lead the activities. Choose your staff member most experienced with successfully leading these activities with students to lead this part of the session. The main body of those write-ups is embedded in this Assessing for Student Learning write-up. If you will be teaching the activity using the embedded write-up, we suggest that you also read through the separate BEETLES activity write-ups for *Mind Pie* and *Decomposition Mission*, particularly the Instructor Support sections, taking notes on the embedded write-up included here.
4. **Identify outdoor areas for activities.** These should be nearby areas. For *Decomposition Mission*, look for a leafy forest floor with many examples of approximately four species of decaying leaves and logs and an area with rotting logs to dig in and roll over. Pay attention to local hazards, such as fire ants, and make adjustments as needed. You'll need a flat space for *Mind Pie*, ideally with plenty of pebbles and leaves. For *Walk & Talk*, you just need room for the group to walk two abreast.
5. **Plan when you might include a break in the schedule.** We recommend a break after modeling the student activities.
6. **If you need shorter sessions...** If *Assessing for Learning* is too long for the time slots you have available, we recommend that you break it into two parts, rather than try to abbreviate it. This session is fairly dense and may also be more effective presented as two sessions. We recommend breaking just before Looking Closely at Student Work. This will result in Part 1 taking about 2 hours, and Part 2 taking about 70 minutes.
7. **Make sure participants are prepared.** Make sure participants bring the gear they need to be comfortable outdoors. Tell them to bring their journals and something to write with.
8. **Prepare copies.** Make copies of each handout for participants. (See list at right.)
9. **Prepare *Mind Pie* chart.** Write the following categories on a large piece of chart paper divided into eight pie-shaped pieces:
   - I can participate in a scientific discussion.
   - I like exploring outside.
   - I like trying to solve nature mysteries.
   - I can explain what happens to dead organisms over time.
   - I can explain how matter moves through ecosystems.
   - I can identify different kinds of decomposers.
   - I can explain how decomposition works.
   - I can explain the role decomposers play in an ecosystem.
10. **(Optional) Make Session Overview to post on wall.** You may choose to make a Session Overview to post on the wall during this session. Some presenters and participants prefer having it so they can see the trajectory of the session.

MATERIALS

For the group:

- ❑ projection system
- ❑ computer
- ❑ slides
- ❑ *Mind Pie* chart
- ❑ Discussion Norms poster
- ❑ Portable white board and dry erase marker
- ❑ bag of ~100 pebbles (unless there are plenty where you will present Mind Pie)
- ❑ Chart paper or whiteboard(s) and markers, 1 per group of 3-4 participants
- ❑ (Optional) Session Overview to post on wall

For each participant:

- ❑ 1 hand lens (optional, but recommended)
- ❑ journal and pen/pencil

Copies and printed materials:

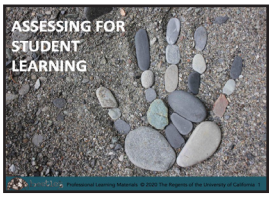
- ❑ *Student FBI Cards* for *Decomposition Mission*, 1 set for each ~15 participants, starting on page 40
- ❑ *Procedure for Looking at Student Work*, 1 per participant, starting on page 43
- ❑ *Student Work Samples*, 1 set for each small group, starting on page 45
- ❑ *General Practices for Using Embedded Assessment to Improve Teaching and Learning*, 1 per participant, page 51

YOU ARE HERE:

10 minutes

Introducing Assessing for Learning

1. **Show Slide 1: *Assessing for Student Learning.* Begin the session.**

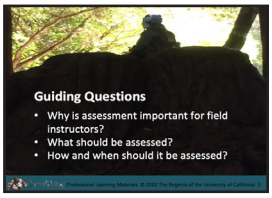


slide 1

   a. Welcome participants. Make sure everyone is ready to begin and has the gear they need to be comfortable during the outdoor experiences.

   b. Explain that the session is about assessing for student learning.

2. **Show Slide 2: *Guiding Questions*. Explain the session's guiding questions:**



slide 2

   a. We'll be thinking and talking about these questions throughout the session.

3. **Discuss guiding questions.**

   a. Tell partners to *Turn & Talk* about the guiding questions.

   b. After a few minutes, ask for everyone's attention.

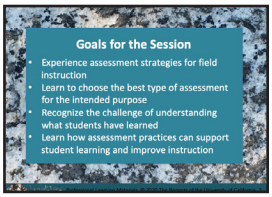
   c. Explain that in this session, we want to think about how assessment can best inform instruction and improve student learning.

   d. Summarize by saying,

   - *It's common for instructors to overestimate how much students understand of what they've taught them. Even when instructors think their students really got a concept, assessments often show their students ending up with a wide variety of both accurate and inaccurate ideas.*

   - *Skilled instructors continuously assess students, adjusting their instruction based on feedback directly from students.*

4. **Show Slide 3: *Goals for the Session*. Briefly review the session goals. Explain:**



slide 3

   a. The session will focus on assessments that can be used while teaching in the field with students.

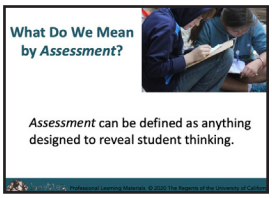
   b. We'll also discuss different types of assessments and how they can be used for specific purposes.

5. **Explain that reflective instructors are curious about what students are thinking and how to use this information to guide instruction:**

   a. Reflective instructors are curious about and constantly trying to uncover what students are thinking.

   b. They use this information to help guide their instruction.

6. **Show Slide 4: *What Do We Mean by* Assessment? Explain:**



slide 4

   a. Take a moment to read the definition.

TEACHING NOTES

Turn & Talk. *Turn & Talk* is a simple discussion routine in which the instructor shares a prompt, and then participants talk about it for ~30–60 seconds. The instructor also participates, partnering with a student, while mostly asking questions and listening to the student. It's unusual to share three questions at once, as is done here, and participants will need ~3 minutes to discuss all three. *Turn & Talk* is often used many times during an instructional experience as an efficient way of breaking up whole-group discussions and giving students opportunities to talk one-on-one. *Turn & Talk* is an opportunity for an instructor to listen to an individual student's ideas and can be used as a form of assessment.

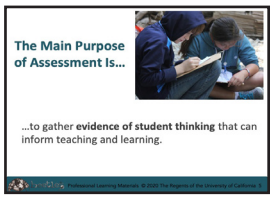
On the use of assessment terms. In this session, assessment jargon has been intentionally kept to a minimum to avoid confusion. We do use the terms *embedded assessments* and *performance tasks* because they are useful and fairly intuitive to understand. Embedded assessments are part of the learning experience—not separate from it. Instructors who have experience with assessment may mention terms such as *summative assessment* and *formative assessment*. Summative assessment refers to assessment that takes place at the end of a chunk of instruction (e.g,. a lesson, a unit, or a course) to measure what students have learned. In outdoor science programs, summative assessments might be used at the end of

(continued on next page)

b. Sometimes, assessment is seen only as a way to find out what students have learned at the *end* of a program.

c. This session is focused on how assessment can be used to find out what students are thinking *during* instruction, when it's not too late to use the information to guide instruction.

7. **Show Slide 5: *The Main Purpose of Assessment Is...* Explain that in science investigations, students gather evidence about nature and, similarly, instructors plan assessments to gather evidence about student learning:**



slide 5

a. The overall purpose of assessment is to collect evidence of student thinking to improve instruction and increase student understanding.

b. There are parallels with doing science. Scientists design investigations to collect evidence and then use the evidence to make explanations about phenomena.

c. An instructor designs assessments to collect evidence of student understanding and uses that evidence to make decisions about what to do next to best support additional student learning.

8. **Explain that assessments give learners information, too. Learners need to be self-reflective about what they understand and how they came to understand it:**

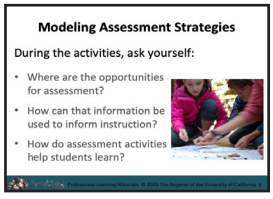
a. The overall purpose of assessment is to collect evidence of student thinking to improve instruction and increase student understanding.

b. There are parallels with doing science. Scientists design investigations to collect evidence and then use the evidence to make explanations about phenomena.

Modeling Assessment Strategies

Model Student Field Activity: *Mind Pie*

1. **Show Slide 6: *Modeling Assessment Strategies.* Explain:**



slide 6

a. We'll be modeling a few student activities that include embedded assessments.

b. *Embedded assessment* means that the assessment is part of the instruction: it's not separate.

2. **Explain to participants that they should participate in the activities as adult learners while also thinking about how students might respond:**

a. You'll be participating as adults, following your own curiosity and discussing discoveries and ideas at your own level.

TEACHING NOTES

(continued from previous page)
your forest ecology day or at the end of a program before students leave. This is what many people think of when they think of assessments, and it includes a variety of forms of tests used to find out what students have learned as a result of their learning experiences. There is a tendency to think of summative assessment as the only type of assessment and to think that it is used only to find out what students learned and to evaluate the success of a program. Formative assessments, which are the focus of this session, are different. These take place during instruction and give educators and learners information that can be used to improve both learning and teaching. An example of formative assessment is listening in on student discussions, which provides evidence of student thinking and sense-making. The terms embedded assessment and formative assessment have subtle differences but are often used interchangeably. If your program uses summative assessments for a particular purpose (e.g., program evaluation, measuring the effectiveness of activities), then you may want to discuss with your staff how information from summative assessments can be used (e.g., to improve instruction for future groups of students).

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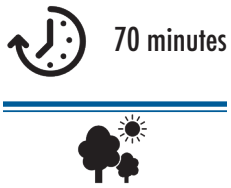


Don't overexplain each section of the Mind Pie. Be careful you don't describe each topic so thoroughly that participants feel that they understand it, based on your introduction. The purpose for clarifying is to make sure they understand what you're asking them to respond to.

TEACHING NOTES

How should participants behave during model activities? We've found that if you ask instructors to act like students, this often leads to exaggerated parodies of student behavior, and the modeling suffers. Instead, ask instructors to participate as adults but to imagine how students might respond. There may be times when they get carried away with discussion of adult content to the point that the effectiveness as a model is also lost. You may need to point this out and remind them that their students may not ask those questions.

Staggering the placement of items during *Mind Pie*. If you have a large group, you may want to orchestrate some kind of staggering for participants to step forward to place their items.

Use responses only as a guideline. Take student responses on *Mind Pie* with a grain of salt. Be aware that people often put pebbles in categories where they still have a lot to learn because they may not be aware of what they don't know. They also sometimes won't want to admit what they don't know.

Embedded Write-Ups. The student activity has been embedded in this professional learning write-up for your convenience. In this section, students/participants are referred to as learners in order to help you identify the parts that are taken directly from the student activity. The blue box also differentiates the student activity from the rest of the session.

   b. The leader will be modeling how to lead the activities with students, so you should support the leader; don't take discussions too far off-topic and focus on how students might respond to the activity.
   c. Acting out negative student behaviors is not helpful. Imagining how your students might respond is helpful.
   d. There will be some questions asked that might seem obvious to you, but are designed for students.

3. **Explain to participants what to look for during the student activity modeling:**
   a. Please participate in the activities and also try to notice the assessment opportunities that are used.
   b. You may not recognize these as typical assessments because they are not written tests or quizzes.
   c. Look for different types of assessments—anytime the instructor is gathering evidence of student thinking.
   d. Think about how you could use this information to guide your instruction.
   e. Also think about how the assessment might affect the learners themselves.

4. **Take participants to the outdoor location you've chosen for *Mind Pie* and introduce the activity.**
   a. Lay out your *Mind Pie* chart in a spot with pebbles and leaves or twigs. Anchor the corners with rocks.
   b. If there are too few pebbles in the area, use the bag of pebbles you prepared.

5. **Explain that *Mind Pie* will help us learn about the group.**
   a. Gather learners in a circle around the *Mind Pie* poster to explain the activity.
   b. Tell learners this activity will give everyone a sense of what the group already knows, what the group feels comfortable doing, and what things will be new.
   c. It will also give them a chance to hear a little bit about what they will be doing during the experience (or even multiple experiences).

6. **Explain each section of the pie.**
   a. Give learners brief and simple explanations for each pie section.
   b. Be careful not to explain each topic so thoroughly that learners think they understand it based on your introduction.
   c. You just want them to understand what you're asking them to respond to.

TEACHING NOTES

7. **Explain how to show what they know: pebble = solid understanding, dead plant piece = room to grow, blank = no experience.**
   a. After about a minute or two, tap the first two participants at your end of the lines and wait for the whole group to become silent.
   b. If they know what a topic means but realize that they have room to grow, they should put a small piece of a stick or dead leaf in that section.
   c. If there's a topic they've never heard of before, or feel very inexperienced with, they should leave it blank.

8. **Explain to learners to be honest to make the activity worthwhile:**
   a. The *Mind Pie* is meant to help learners think about their own learning and also to help the instructor and learners gauge the group's experience and understandings.
   b. Sometimes learners put all stones or mostly stones because they think that putting plants might make them look bad.
   c. However, then the *Mind Pie* becomes useless. Awareness of what you don't know is a good thing.
   d. This is a group process, not a graded test, and no one will know who put what where.

9. **Discourage tossing items and accidentally kicking the *Mind Pie*. Explain:**
   a. Carefully place one item at a time in a section and don't step over the poster.

10. **Learners place materials on group *Mind Pie*.**
    a. Allow about 2 minutes for learners to place materials on *Mind Pie* sections.
    b. Depending on the size of your group, you can have learners work all at once or split the group so only a handful fill in the pie at a time.

11. **Explain how reflecting on learning can help prepare us to learn and tell participants to begin:**
    a. When you're getting ready to learn, it's important to recognize what you don't know or fully understand. This can help make you a better learner.
    b. Be honest and don't worry about others seeing where you put your items.
    c. The main thing is to see where the whole group feels strongest and weakest in their knowledge and skills.

12. **Look for patterns and discuss. Ask learners the following questions to see what they notice about the *Mind Pie* as a whole:**

    ▶ *What do you notice about our* Mind Pie*?*

TEACHING NOTES

- *What can you say about our group based on this information?*
- *In what area(s) is there more awareness of room to grow?*
- *In what area(s) does this group seem particularly strong?*

13. Reassure learners as necessary about any particular topics.

a. If you notice any topic in particular that includes a lot of plants, reassure them that it's okay and that we all have room to grow in what we know.

14. Explain they'll experience these topics and later will reflect on growth:

a. You'll experience these topics throughout the day, and later we'll see where you may have grown.

15. Debrief the use of the *Mind Pie* activity as an embedded assessment. Ask and explain:

a. What could you learn about your students by doing this before conducting a field experience? About individuals? About the group?

b. What *don't* you learn from doing a *Mind Pie*? What are its limitations as an assessment tool?

c. This type of group self-assessment activity is designed to get a general sense of the group's exposure to and comfort with the topics on the chart.

d. This activity gives students a chance to access their prior knowledge about related experiences and ideas they might have had before coming to you.

e. Think about whether the *Mind Pie* will influence how you teach. Will you go deeper on topics students already know something about, or will you put more emphasis on topics they know less about? What questions will you ask to learn more about how accurately they self-assess their understanding?

f. Some possible extensions for *Mind Pie* might be: having students write in their journals about their self-assessment or take a photo of the pie, then do it again at the end of the day/week, and compare how it's changed.

Model Student Field Activity: *Decomposition Mission*

1. Introduce the activity by asking learners what they think happens to the matter from living things when they die.

- *If living things have been living and dying here on Earth for millions of years, why aren't we hiking through all their dead matter right now? Where has all that stuff gone?*

a. Allow a few learners to share out their ideas. If they say "decomposition" or "they decomposed," ask them to describe what they mean by those words.

Defining *decomposition* with younger students. With younger students, consider stating the definition in simpler terms, such as: "Decomposition is when dead things and their wastes rot. They are broken down into smaller pieces, or changed into different types of materials like poop, rotten fruit, water, and air."

Opportunity to model a student safety talk for participants. Your model safety talk should include: Rolling logs or rocks toward their body so any surprised organisms (like snakes) won't jump out toward them; Not putting fingers or hands where they can't see; Gently returning logs or rocks to their original position to preserve a moist or protected habitat.

2. Use a fresh leaf and soil to introduce first and last stages of decomposition.

a. In one hand, hold up a fresh green leaf; in the other hold some soil. Ask:

▶ *How could a leaf become part of the soil like this?*

b. Listen to their ideas and then introduce this definition:

▶ *Decomposition is the process of rotting or decaying. It's when dead organisms and their wastes are broken down into smaller and simpler forms of matter—such as nutrients, carbon dioxide, water, and organic matter that all become part of soil, air, and water.*

3. Explain that by looking closely at different stages of decomposition, they can find evidence of how this happens:

▶ *Today we're going to explore and study decomposition in action to try to figure out how it happens.*

Decomposition Displays

1. Groups of ~4 find and lay out stages of leaf or wood decomposition.

a. Divide learners into groups of ~4. Assign each group to a different type of abundant leaf or wood (e.g,. oak leaves, birch bark, pine wood) that has already fallen.

b. Tell them to begin making displays organizing samples from fresh (e.g., the least decomposed) to part of the soil (e.g., the most decomposed).

c. If you're at the seashore, you can do this with samples of algae.

▶ *Your mission is to make a display that shows the stages of decomposition of the leaves or wood you were assigned, going from fresh to being part of the soil. Try to include as many stages of decomposition as you can.*

2. Circulate, ask questions, and troubleshoot.

a. Circulate as learners work. Ask questions and encourage them to explain their reasoning behind putting pieces in a particular order.

b. Encourage them to make comparisons between stages of decomposition.

c. Ask questions such as:

▶ *What characteristics are you using to decide which things are more decomposed than others (e.g., dry, brittle, soft, with holes, more grayish)?*

3. Groups present displays to one another and describe characteristics they used to generate the order of decomposing materials.

a. Allow each group to present their work to the whole group, or give groups time to check out one another's displays.

b. Ask learners to explain to others what characteristics led them to classify objects as more decomposed or less decomposed.

TEACHING NOTES

Continue reminding students of the definition of *decomposition*. There is a lot to absorb in the definition of *decomposition*. Throughout the activity, use variations of the definition to help direct student thinking (e.g., *So you think that's a decomposer? How do you think it breaks dead stuff down into simpler forms of matter, like soil, water, and CO_2 in the air?*).

Note about pre-teaching. In this model activity, we assume that students have already been introduced to the terms producers, consumers, and decomposers.

Ask probing and challenging questions. Throughout this discussion, be sure to ask probing questions to uncover thinking (*What makes you think that?*) as well as some challenging questions to push their thinking (*What about this? Have you thought about...?*).

Make sure to emphasize how their displays are scientific models. Models are used by scientists to represent a system that's being studied; to help develop questions, predictions, and explanations; as well as to communicate ideas to others.Models can be diagrams, physical structures, and/or computer simulations. A model diagram makes the underlying processes more visible and accessible when they are difficult to observe directly. By developing a model diagram that represents their understanding of decomposition, students are actively building on their own explanations and also communicating ideas with others.It can be helpful to discuss how the displays can be both accurate and inaccurate models. Examples of inaccuracies in this model of decomposition: all the pieces represent what happens to one piece over time, it happens over a long period of time, it doesn't show all the steps. For more on models, see Featured Science and Engineering Practices in the Instructor Support section of the Decomposition Mission student activity guide.

TEACHING NOTES

4. **Ask learners to share characteristics that the decomposing leaves and sticks from different displays have in common:**
   a. What are some characteristics for decomposition that the decomposing leaves and wood from different group displays share in common (e.g., dry, brittle, soft, with holes, more grayish)?
5. **Point out evidence in displays, such as holes or sponginess of wood, of something missing and then ask where it may be now. For example:**
   - *See the holes in this wood? There used to be wood there, but now it's not there anymore. Where could it have gone?*
   - *Feel how spongy this wood feels. That's evidence that stuff that used to make it feel hard is missing. Where could that stuff be now?*
6. **Connect displays to models used in science. Explain:**
   a. When scientists try to understand a process like decomposition, they often create models similar to these to make predictions about what they might see in nature over a long period of time.
   b. Then they might also check to see if their model is accurate by leaving the material outdoors to decompose more while carefully recording what happens.

Search for Decomposers

1. **Ask learners to describe evidence of what causes things to decompose that they have seen in their displays or elsewhere:**
   a. Think back on the leaves and wood in your displays and remember anything you saw that might be evidence of what is causing things to decompose (e.g., *We saw tiny holes that could be evidence of an insect eating it.*).
   b. You can also bring up evidence you've seen during other parts of the field experience or any other time of your lives.
2. **Gather the group around a display that has clear evidence of things breaking down into both smaller and simpler parts.**
   a. For smaller, you might have leaves or wood broken up into smaller pieces.
   b. For simpler, you might have termite frass or soil with lots of organic matter in it (leaves/wood that have been changed into a different substance).
3. **Introduce part of decomposition as breaking down things into *smaller* parts. Then ask for examples.**
   a. Explain: There are two parts to decomposition..
   b. Explain: When you break up a leaf or piece of wood, you're breaking down things into smaller parts, but not necessarily simpler parts.
   c. Point out an example of this in the display.

Decomposition is not just stuff breaking down into soil. Many students (and adults) define *decomposition* as organisms turning things into soil, which is inaccurate, terrestrial-centric, and very annoying to marine educators. Think about all the decomposition that happens in the ocean, which covers nearly three-quarters of Earth's surface, plus all the lakes, ponds, and rivers. Even when decomposition produces soil on land, the process also produces water and releases carbon dioxide into the air.

What's the matter? If your students aren't sure what is meant by *matter*, you may need to help them with an accessible definition such as: stuff, a physical substance, something that has mass and takes up space. Some examples of matter: *This tree is made of matter, the water is, you are, air is. All the stuff in the universe is matter. However, energy, such as heat or light, is not matter.*

Decomposition involves chemical and physical changes. When we discuss breaking down things into smaller parts, we're referring to the physical changes in decomposition. Breaking down things into simpler parts is an introductory way of describing how chemical bonds are being broken, and new ones are formed. By middle school, students should begin to understand that organic matter is changed into different, simpler substances through the process of decomposition.

4. **Demonstrate breaking down something into smaller parts with a dead leaf or piece of wood. Say:**

   ▶ *Each smaller piece of wood (or leaf) I'm breaking off is smaller, but it's still made of the same stuff. It's just smaller pieces of wood (or leaf).*

5. **Ask learners for examples of other things that might break down leaves or wood into smaller parts (e.g., chewing, stomping, grinding). Listen to their ideas.**

6. **Explain another part of decomposition as breaking down things into *simpler* parts—different stuff—such as poop, CO_2 and H_2O. Point out examples in the display:**

   a. Decomposition isn't complete until dead things are broken down into *simpler* parts that are made of a different substance than what they formerly were.

   b. When grass is cut or stomped on, it's just becoming smaller pieces of grass.

   c. When bacteria living in the gut of a deer digests grass, the grass is changed into poop, carbon dioxide, and water, which are all different substances than grass.

   d. The bacteria in the deer's gut are decomposers.

7. **Ask learners for other decomposition examples they can think of in which things are broken down into simpler parts. (There are many!)**

8. **Explain that scientists put organisms in categories that describe the role they play in an ecosystem and how they get their food in an ecosystem.**

9. **Explain that decomposers are organisms that break down things that used to be alive, as well as the waste of organisms, into simpler parts that can be used by plants and algae:**

   a. Some organisms have a special role in the ecosystem because they make decomposition happen—they're called decomposers.

      ▶ *Decomposers are organisms that break down dead plants, algae, animals, and other organic matter into simpler forms of matter, such as nutrients that become part of soil, the air, or large bodies of water. Decomposers break down things into forms of matter that plants and algae can use to build and grow.*

10. **Introduce FBI's (fungi, bacteria, and invertebrates), show learners the FBI Cards, and ask what FBI's might look like in the environment.**

    a. Let learners know that they will have a chance to search for decomposers in the area. It will be easier to find decomposers once the group knows what they look like.

    b. Show and pass around images of fungi and ask learners to describe what they see. Round spots on leaves, white thread-like stuff in dirt, and decomposing logs may be fungi or evidence of fungi.

TEACHING NOTES

Decomposer describes the role within an ecosystem. When students learn that invertebrates are decomposers, they often assume that these organisms only eat dead things or that they can't eat anything but dead material because it's not their job. Avoid perpetuating this misconception–tell students that invertebrate decomposers don't always eat dead things. They often eat things that are still alive.

Not all invertebrates are decomposers. Some students carry the misconception that every invertebrate is a decomposer. Let students know that finding an invertebrate under a log does not necessarily mean it's a decomposer. When discussing what they found, encourage students to use language of uncertainty. For example: *I found an insect that looks like a beetle, which might actually be a decomposer.*

Fungus or bacteria? Spots on leaves are evidence of bacteria and fungi. Round spots are more likely from fungi because fungi tend to grow outward in circular patterns.

About humus. Humus is the organic matter in soil resulting from decomposition (not to be confused with hummus, the Middle Eastern food dip, which is much tastier to humans).

TEACHING NOTES

Passing around FBI Cards. If you have a group of more than 15 participants, make sure to pass around a few sets (1 set per 15 participants, approximately) so everyone has the opportunity to see the cards.

Model how to look for decomposers. Model digging in the leaf litter and duff (decayed organic matter) and decaying wood or peeling bark away from logs to get students exploring actively. Refer to the *BEETLES Ecosystem Literacy and Exploration Guide* for more on Under Log exploration.

c. Show and pass around images of fungi and ask learners to describe what they see. Round spots on leaves, white thread-like stuff in dirt, and decomposing logs may be fungi or evidence of fungi.

d. Show and pass around images of invertebrates and ask learners to describe what they see.

11. Explain to learners that decomposers, though often tiny, leave evidence behind, such as spots on leaves, holes, tunnels, poop, etc.:

a. Although many decomposers, such as microscopic bacteria and fungi, are hard to see, there are ways to see where decomposers have been at work.

b. In fallen logs, you can find small invertebrates, as well as tunnels or droppings, as evidence of invertebrates.

c. Holes or bites in leaves are sometimes evidence of invertebrates.

12. Give safety talk about finding decomposers:

a. Don't touch any organisms without an instructor (except plants, if you know they're safe to touch).

b. Roll logs toward your body. (Demonstrate this.)

c. Don't put fingers where you can't see, to avoid accidentally touching harmful organisms such as scorpions or snakes.

d. Gently return logs or rocks to their original positions to preserve moist habitat.

e. Provide warnings about any harmful organisms you are aware of in the area.

13. Learners search for decomposers while instructor circulates.

a. Tell learners they'll spend ~10 minutes searching for decomposers and evidence of decomposers.

b. As you're searching with them, ask broad questions to encourage exploration and thinking:

- *What evidence have you found? What does the evidence tell you?*
- *What organism could have made this happen to the wood or leaf?*
- *What do you think it eats? Where might it get the matter it consumes?*
- *Where did you find the most evidence of decomposers? The least amount of evidence?*

14. Gather the whole group and ask a few learners to share what they found:

a. Ask: "What did you find?"

b. Listen as learners share discoveries and then take the group to directly observe any evidence that seems particularly interesting.

15. **Ask where they found the most and least decomposers and what it is about those areas that made them good or bad for decomposers.**
    a. Where did you find the most decomposers/evidence of decomposers? What made it possible for the decomposers to live there?
    b. Where did you find the least decomposers/evidence of decomposers? What made it less hospitable for them to live there?

Making Decomposition Diagram Models

1. **Explain that the decomposition displays they made were a type of a model of decomposition and that now they'll make a different type of model: a diagram.**

2. **Explain that they're each going to make a diagram/model—including drawing, writing, lines, and arrows—showing what they understand about decomposition.**

3. **Write the following on paper/whiteboard and then tell learners to include all these in their diagrams/models (and post where it can be seen throughout the activity):**
    - Show an example of decomposition.
    - Explain how decomposition happens.
    - Include decomposers.
    - Show results of decomposition.

4. **Demonstrate quick examples, using their suggestions.**
    a. On a whiteboard, show how to make a diagram/model, including drawing, writing, lines, and arrows.
    b. Ask what they might write or draw to show an example of decomposition and quickly sketch and write what they suggest.
    c. Do the same for the other points they need to include (how it happens, examples of decomposers, and examples of the results of decomposition).
    d. Use arrows to show when something changes into something else and lines to show connections.
    e. Erase and quickly model another example suggested by students.

5. **Explain the value of using drawings, labels, writing, arrows, and lines in a model:**
    a. Drawings are good for showing things that are hard to describe or see.
    b. Lines are good for showing specific connections between things.
    c. Labels can be used to describe something that's hard to draw (such as air), to say what something is, to say what an arrow represents, etc.
    d. Writing can also be used to explain ideas or observations.
    e. Arrows are useful for showing when something changes into something else.

TEACHING NOTES

More about performance tasks. A performance task is any learning activity or assessment that asks students to demonstrate their knowledge, understanding, and/or skills. Performance tasks involve students creating a tangible product or completing a specific task that serves as evidence of learning. Unlike a multiple-choice test that asks students to select a response from a set of possible answers, a performance task presents a situation or challenge that calls for learners to apply their learning in context. In that way, students are extending their learning, and the instructor can uncover how students are making sense of what they're learning.

Assessment opportunity. As you circulate, pay attention to what students have included or not included in their diagrams. Ask questions and use this opportunity to find out as much as you can about what they do and don't understand. Use this information to build upon later, to inform which clarifications to bring up later, or which follow-up activities to do. If possible, collect students' journals at the end of the experience so you can more carefully read what they've written and drawn to understand their thinking.

Including non-terrestrial examples in models. If you are near a stream, a lake, or the ocean, consider asking students to include these in their models and to try to explain how decomposition happens in water..

TEACHING NOTES

How to resolve discussion: *Are humans decomposers?* If you discuss this question with students, make sure to let them know that humans *do* contribute to decomposition, but scientists do not usually consider humans to be decomposers. There is plenty of ambiguity within these ecological categories, but the *decomposer* label is used for organisms that primarily break down matter into substances that can be used by plants to grow. Of course, the bacteria in our guts (which is part of us) are considered decomposers, so we carry our own little private posse of decomposers that help us survive. See the Instructor Support section of *Decomposition Mission* for more on this.

Opportunity to contrast producers. If students bring up plants during this discussion, let them know that they are actually producers—It might be helpful to frame producers as composers in contrast to decomposers—because plants take in carbon dioxide and water and then make more complex matter out of it. Producers do the opposite of what decomposers do with matter.

Concluding the discussion. As part of concluding the decomposition discussion, consider telling students that some scientists consider only bacteria and fungi to be true decomposers. From this point of view, worms would not be considered decomposers, although the bacteria in worm guts that help them break down matter would be the decomposers.

Common misconception about plants and soil. It's a common misconception that plants build their mass from minerals they get from soil. Minerals are important to plants to function, like vitamins are important to us, but they are not food. The bulk of the matter in plants comes from CO_2 from the air and H_2O, both of which are used to build sugars in the presence of sunlight.

6. **Ask learners to include examples they've seen today and also from other parts of their lives:**
   - **a.** Today, you've seen examples of decomposition and of decomposers.
   - **b.** You've also seen examples in other parts of your life.
   - **c.** Describe what decomposition is and how it happens.
   - **d.** Include examples from today and/or include examples that you know about from earlier.

7. **Each learner creates a diagram/model while discussing with a partner for ~5–10 minutes.**
   - **a.** Tell learners to find a partner to discuss and complete their diagrams together.
   - **b.** As they're working, circulate and ask questions to help you understand their thinking.
   - **c.** Also ask questions that might help them improve their diagram model (e.g., *How do growing plants fit into all of this?* or *How might you add arrows to show how things are changing?*).

8. **Tell each pair to join another pair to share and compare. Explain:**
   - **a.** Share what's similar and what's different.
   - **b.** Feel free to change or add to your diagram after sharing and discussing with others.

Decomposition Discussion

1. **Encourage a free-flowing discussion about decomposition.**
   - **a.** After pairs have completed their model diagrams, ask learners if they have any questions or ideas about decomposition for the group to discuss.
   - **b.** Use some or all of the following questions to lead a discussion:
     - *Where is the stuff that used to be part of the wood now?*
     - *Why is decomposition important for ecosystems?*
     - *What other things can you think of that might help make decomposition happen?*
     - *Can humans be considered decomposers? Why or why not?*

2. **Use a student model or a nearby example to explain the importance of decomposers to ecosystems: breaking down dead things into CO_2, H_2O, and minerals that plants and algae can use to grow.**
   - **a.** At some point, select a learner model that includes a plant and point out that it takes decomposers to break down dead things into carbon dioxide gas (as well as water and nutrients), which can be used by plants.

b. If you are near the ocean, a lake, or a stream, explain that they contain photosynthesizing organisms that are not plants (such as microbes, phytoplankton, and algae) that also depend on these nutrients and CO_2.

- *Decomposers are important for ecosystems because they make matter available both for plants and for other photosynthesizing organisms, such as algae.*

3. Explain that once matter becomes carbon dioxide gas, it takes photosynthesis by plants for it to change into matter that living things can consume again:

a. It takes a lot for carbon dioxide to change into matter that living things can consume again: it takes photosynthesizers.

b. Through photosynthesis, plants, algae, phytoplankton, etc. make carbohydrates from carbon dioxide and water, using energy from the sun.

- *Plants and algae are important to ecosystems because they make matter available as food for living things.*

c. Tell learners that if their ideas have changed during the discussion, they have a few minutes to add to or change their diagrams to show this.

Wrapping Up: Reflecting on Decomposition

1. Lead learners in a *Walk & Talk* or *Turn & Talk* discussion.

a. Ask the following questions to encourage learners to reflect on their learning process:

- *Describe something new that you learned about decomposition.*
- *How would you describe decomposition to someone who didn't know anything about it?*
- *How does a leaf become part of soil? Part of the air? Part of water?*
- *How might this area look different without decomposition?*

2. Share out their ideas and review the definition of *decomposition*.

a. Ask learners to share any interesting ideas they heard from their discussion partners.

b. Summarize the ideas that are shared.

c. Review the definition for *decomposition*:

- *Decomposition is when dead organisms and their wastes are broken down into smaller and simpler forms of matter—such as nutrients, carbon dioxide, water, and organic matter—that all become part of soil, air, or bodies of water.*

TEACHING NOTES

For more advanced groups, consider using these additional discussion questions:

- *How long might it take different materials, such as wood, glass, or plastic, to decompose? How could you find out?*
- *Do you think scavengers, such as vultures, should be grouped as decomposers? Why or why not?*
- *How do you think decomposition might happen in the ocean?*

***Walk & Talk* student trail activity.** If you have never led a *Walk & Talk* activity, read the BEETLES *Walk & Talk* student activity write-up to learn how to introduce the rotating partners procedure for discussing questions in pairs as they walk.

Adjust the assessment planning discussion, depending on the background of your staff. The planning information included in this session is presented at a basic level. If you have staff with assessment training, you might want to include them in sharing their expertise or experience they have with the challenges involved in developing assessments so you can accurately gauge student progress.

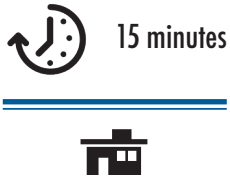
TEACHING NOTES

3. **Challenge learners to find more decomposers and evidence of decomposition as they continue with their field experience.**

4. **Encourage learners to keep looking at nature through the lens of matter cycling.**

   a. Ask learners to look at all the plants, dead plants, soil, water, and air around them and to think about how matter is cycling through them.

YOU ARE HERE:



Debriefing Embedded Assessment Opportunities in *Decomposition Mission*

1. **Bring participants indoors to brainstorm the embedded assessment opportunities in the activity.**

   a. Ask what assessment opportunities they noticed during the activity that could give the instructor insight into or evidence of student thinking and learning.

   b. Record these in a column labeled "Assessment Opportunities" on the far left of a whiteboard/sheet of chart paper. This will eventually be a chart with four more columns, so leave room.

   c. To help them notice some of the more subtle opportunities, ask:

      ▶ *What did the leader do or say to gain insight or gather evidence of student thinking and learning?*

2. **If they don't mention the following, add each item to the list:**

   - **Opening questions:** At the beginning, the instructor asked why there aren't dead things everywhere and what is meant by *decomposition*
   - **Group displays:** The instructor assigned groups to make displays showing stages of decomposition and paid attention to how they applied decomposition ideas to their displays.
   - **Questioning groups:** The instructor questioned small groups as they built their displays.
   - **Groups sharing displays:** The instructor listened to students share their displays with the whole group.
   - **Noticing evidence-explanation connections:** The instructor paid attention to how learners connected evidence to explanations.
   - **Individual diagrams:** The instructor assigned individual students to make diagrams/models of their understanding about decomposition.
   - **Looking at diagrams:** The instructor observed student decomposition diagrams/models.
   - **Diagram share:** The instructor asked questions and listened during the whole-group share of diagrams/models.
   - **Listening to discussions:** The instructor listened to student discussions throughout the activity and paid attention to student reasoning and how learners connect evidence to explanations.
   - **Reflection questions:** The instructor listened to learners respond to reflection questions.

TEACHING NOTES

3. **Explain that these were part of the lesson, so they're embedded assessments.**
   a. All these were part of the instruction, so they're called embedded assessments.
   b. Through embedded assessments, an instructor can identify what students understand and whether there are gaps in understanding and can act on them immediately.

4. **Add columns and ask if each opportunity primarily assesses individuals or groups.**
   a. Add "Individual or group?" as the heading of a second column on the chart.
   b. Quickly move through the list, asking if each item mostly assesses group or individual understanding, writing an "I" for individual and "G" for group.

5. **Group shares other ways of collecting evidence of group or individual understanding. Explain:**
   a. What are some different ways you have collected evidence of group understanding? (Thumbs up, other hand signals, etc.)
   b. In the *Mind Pie* activity, the goal is to get a sense of where the group is starting with different topics and skills.
   c. What are some other ways you can think of to collect evidence of individuals' understanding?

6. **Add column and ask if each opportunity includes students sharing in oral or written form.**
   a. Add "Oral or written?" as the heading of a third column on the chart.
   b. Quickly move through the list, asking if each item gives the instructor oral or written evidence of student ideas, writing an "O" for oral and "W" for written. (All but decomposition diagram will likely be O.)
   c. Ask: "What are the advantages and drawbacks of oral evidence of student understanding? Of written?" (Listen to their ideas.)

7. **Add column "Students explain in own words?" and ask if each opportunity asks students to explain their thinking in their own words.**
   a. Add "Students explain in own words?" as the heading of a fourth column on the chart.
   b. The most effective way to make student thinking visible to the instructor—and to themselves and other students—is to ask them to explain something in their own words.
   c. Explain: This is different from students repeating back what they've been told, which doesn't tell you much about their understanding.
   d. Quickly move through the list, asking if each item gives students an opportunity to share their thinking in their own words, writing "Y" for yes and "N" for no. (Most, if not all, will likely be Y.)

TEACHING NOTES

8. **Explain that a key aspect of quality embedded assessment is asking students to explain their thinking:**
   a. To get an accurate picture of how learners are making sense of activities, instructors need to give students opportunities to explain their thinking in their own words.

9. **Add column "How does it support student learning?"**
   a. Add "How does it support student learning?" as the heading of a fifth column on the chart.

10. **Explain that the best assessments give instructors both evidence and provide learning opportunities for students.**

11. **Ask participants to *Turn & Talk* about how each item on the list might support student learning.**

12. **After a few minutes, get the attention of the group and ask a few volunteers to share their ideas about learning opportunities for students during assessment opportunities.**
   a. Call on a few individuals to share their ideas about what they noticed about learning opportunities embedded in the assessment activities.
   b. Explain that many of the items involve students explaining, and when students explain their thinking, they're actively making sense of their experiences—which is learning.

13. **Discuss how performance assessments can support instruction. Explain:**
   a. Groups making the stages of decomposition displays and individuals making the decomposition diagrams/models are examples of performance assessments. Ask:

      ▶ *What could be some purposes for performance assessments during instruction? (Listen to their ideas.)*

14. **Explain some reasons for doing performance assessments, if they haven't already been mentioned:**
   a. They gather evidence of learning during the lesson.
   b. They give students in-the-moment opportunities to apply concepts and skills they've learned or are in the process of learning.
   c. Performance tasks during an activity allow instructors to probe deeper into student thinking and can give a glimpse of how students are making sense of the ideas and activities as they unfold.
   d. They give the instructor insight into how learners are actively constructing their understanding and areas in which their understanding is incomplete.
   e. Students demonstrate their understanding by doing something, rather than merely repeating words they recall.

TEACHING NOTES

15. Ask for examples of performance assessments your participants have used:

a. What are examples of performance assessments you've used before, during, or after instruction. (Listen to their ideas.)

16. Discuss the value of individual students' making visual diagrams/models of their understanding of decomposition. Ask:

▶ *How can having students build diagrams/models of their understanding provide information about their thinking? What could you find out that might be harder to find out through talking? (Listen to their ideas.)*

17. Point out how using the diagram/model also affects student learning.

a. Co-constructing diagrams/models helps students figure out their understandings together as they respond to one another's ideas.

b. The whole group has a visual model that stimulates and deepens their thinking about decomposition.

c. It's an example of how assessment and instruction are really two sides of the same coin and can work together to improve learning experiences for students.

Planning for Assessment

YOU ARE HERE:

20 minutes

1. Explain that it's important to thoughtfully plan for any kind of assessment:

a. The embedded assessment strategies we experienced were thoughtfully planned.

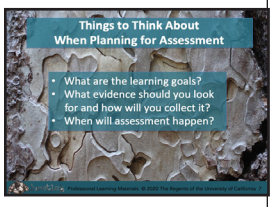
b. Assignments such as the stages of decomposition and the decomposition diagram/model need planning.

c. It's also important to plan for more casual embedded assessments, such as listening in on student talk.

d. It's good to think in advance about assessment opportunities and what you'll be listening for.

e. Now we'll take a look at some things to think about when deciding how to best assess your students' progress.

2. Show Slide 7: *Things to Think About when Planning for Assessment*. Introduce helpful starting points for planning assessments that will then be discussed next, one at a time.



slide 7

a. What are the learning goals? Think about what you want students to be able to do and understand.

b. What evidence should you look for and how will you collect it? You need to match the goals with the type of evidence that can be collected. What kind of evidence should you look for to know where students are in terms of your goals?

TEACHING NOTES

c. When will assessment happen? Decide when to do assessment during instruction.

3. Show Slide 8: *What Are the Learning Goals for Students?* Brainstorm different types of goals for behaviors/attitudes, science practices, and conceptual learning that could be achieved during instruction. Explain:

slide 8

a. Since we can't assess everything, we need to decide on priorities for what we want to learn from embedded assessments.

b. What are some potential behaviors or attitudes you might assess (e.g., curiosity about the natural world, enthusiasm for exploration)?

c. What are some science practices you might assess (e.g., making close observations, using language of uncertainty, citing evidence, discussing ideas)?

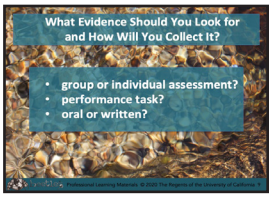
d. What are some possible conceptual learning goals (e.g., disciplinary core ideas) you might assess?

4. Explain that keeping clear goals in mind helps us notice student progress and refine how and what we teach:

a. Keeping your goals firmly in mind before leading an activity allows you to pay closer attention to student progress while you're teaching.

b. If you have clear teaching goals, you can focus and refine how and what you teach.

5. Show Slide 9: *What Evidence Should You Look for and How Will You Collect It?* Explain the importance of thinking about different kinds of evidence that can be collected through assessments:



slide 9

a. There are different kinds of evidence you can collect.

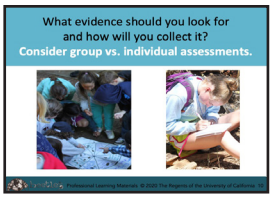
b. Depending on your goals, there are specific advantages to collecting different types of evidence:

- Should it be a group or an individual assessment?
- Should it be a performance task in which students create a product or demonstrate a skill?
- Should it be oral or written?

c. We'll look at examples to practice thinking about how to match the assessment evidence you collect to your goals.

TEACHING NOTES

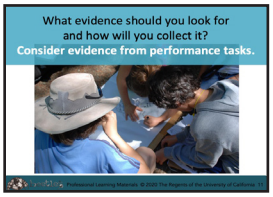
6. **Show Slide 10: *What Evidence Should You Look for and How Will You Collect It? Consider group vs. individual assessments.* Explain advantages and disadvantages of group assessments:**



slide 10

   a. A group assessment is often easier because it takes less time than assessing each individual.
   b. Doing a group assessment can give you a general sense of how the majority of students are progressing.
   c. One disadvantage of group assessments is that you don't get much evidence of individual understanding.
   d. With group assessment, it's harder to identify particular students who are struggling with an idea.

7. **Show Slide 11: *What Evidence Should You Look for and How Will You Collect It? Consider evidence from performance tasks.* Explain the rationale for collecting evidence from performance tasks:**

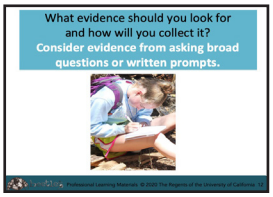


slide 11

   a. In a performance task, students are asked to do something or make something that demonstrates their ability or understanding.
   b. Performance tasks can show the depth and nuances of students' understanding. However, they often take more time and require some type of written or verbal explanation.
   c. This slide shows students creating a food web based on what they've learned about matter cycling through ecosystems.

8. **Brainstorm performance tasks that students might do to show their behaviors, science practices, or conceptual learning.**
   a. What are other performance tasks that students could do that might show their abilities and what they're thinking during instruction?
   b. What kind of assessment information do these types of tasks provide?
   c. Performance tasks are valuable learning opportunities for students to apply new knowledge.
   d. They're also valuable for instructors, helping them learn more about how students use and/or extend what they've learned.

9. **Show Slide 12: *What Evidence Should You Look for and How Will You Collect It? Consider evidence from asking broad questions or written prompts.* Explain how planning broad questions is important for assessment.**



slide 12

   a. Asking appropriate broad questions and carefully listening to responses is key to both teaching and assessment.
   b. Asking broad questions that have a variety of acceptable responses during discussion and written assignments can lead to deeper thinking.
   c. Broad questions also reveal struggles that students are experiencing.

More on broad questions. For more about broad vs. narrow questions, see the BEETLES professional learning session titled *Questioning Strategies.*

TEACHING NOTES

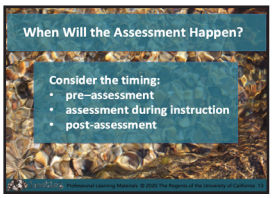
You are a hero! Someday, they will sing long campfire ballads honoring you, oh noble outdoor science program leader! They will erect statues built from recycled materials commemorating your presence on Earth and in this field. They will make a plaque thanking you for how hard you worked while preparing to lead *Assessing for Learning* with your staff. Bark beetles will carve your name in decomposing trees. Hordes of ants will assemble to form the letters of your name on the ground, so large that it will be seen by satellites (unfortunately, though, they will probably misspell it—dang!). Whales will moan your name across the depths of the ocean. Even now, as you work, a giant granite batholith is being formed in your honor deep within Earth, your descendants will see it emerge in a few million years, and they will weep with gratitude as they remember your tremendous efforts. Now back to work!

d. Some broad questions are better than others at inspiring students to share their ideas relevant to a topic. It's helpful to plan some questions in advance and to think about how students might respond to them.

e. Planning questions that might help collect evidence about how students are progressing related to learning goals can allow you adjust your teaching as you go.

f. We will explore broad questions more in the next activity when we'll think about how to get the most from students' written responses.

10. Show Slide 13: *When Will the Assessment Happen?* Consider the timing. Explain how the timing of the assessment can make a difference:

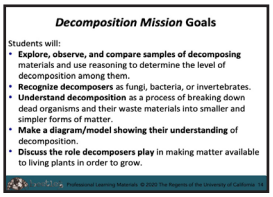


slide 13

a. You can get various kinds of information by assessing at different stages of instruction.

b. We'll use the embedded assessments you just experienced as examples as we think about the timing and type of assessment method.

11. Show Slide 14: *Decomposition Mission Goals*. Discuss pre-assessment methods and purposes.

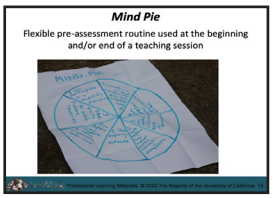


slide 14

a. These are the goals of the *Decomposition Mission* activity in which you took part.

b. What kinds of questions or prompts might you use as pre-assessments to find out students' ideas about these at the beginning of an instructional experience? (Listen to their ideas.)

12. Show Slide 15: *Mind Pie*. Explain that *Mind Pie* can be used pre- and post-instruction, and this one was meant to be used before *Decomposition Mission*.



slide 15

a. *Mind Pie* is an example of an assessment that can be used with different topics before instruction begins.

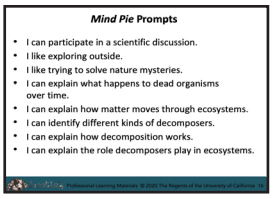
b. *Mind Pie* can also be used at the end of instruction. You can compare the pre- and post-*Mind Pies* to observe changes and reflect on learning.

c. In this case, *Mind Pie* gave prompts for the group to access prior knowledge related to *Decomposition Mission*.

d. *Mind Pie* can also be used to prompt individual students to write in their journals about things they know more about and less about.

TEACHING NOTES

13. Show Slide 16: Mind Pie *Prompts*. Explain that in a pre-assessment, your prompts should reflect your goals, help learners access their related prior knowledge, and help the instructor make choices about where to begin instruction.



slide 16

- **a.** These are the prompts from the *Mind Pie* activity.
- **b.** Note that they're not just about conceptual understanding; they also include attitudes and practices.
- **c.** This is an example of how your goals should inform your assessment prompts: you should assess what you think is most important for students to learn.
- **d.** Your prompts should help learners access their prior knowledge and help you make choices about where to begin instruction.

14. Explain that this *Mind Pie* showed patterns of our group knowledge and attitudes:

- **a.** During *Mind Pie*, responses were collected fairly anonymously and showed patterns of prior knowledge and attitudes for the group as a whole.

15. Brainstorm other reasons for doing a pre-assessment.

- **a.** Ask:

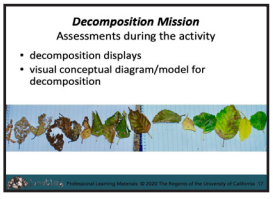
  ▶ *What other reasons can you think of for doing a pre-assessment?*

- **b.** Listen to their ideas.
- **c.** Add any of the following, but only if they have not been mentioned:
  - To encourage learners to begin thinking about a topic to prepare for learning.
  - To access students' prior knowledge for the sake of both students and the instructor.
  - To find out how students are using science vocabulary and concepts.
  - For English learners, accessing prior knowledge also creates a helpful linguistic context—it reminds learners of important academic vocabulary related to the content.

16. Explain that a pre-assessment gives an instructor information they can use to adjust instruction to their students' levels. Ask:

- **a.** What choices might instructors make based on the responses they receive to a pre-assessment?

17. Show Slide 17: Decomposition Mission*: Assessments During the Activity.* Assessments can take place during an activity.



slide 17

- **a.** There are many ways an instructor can use embedded assessment during instruction.

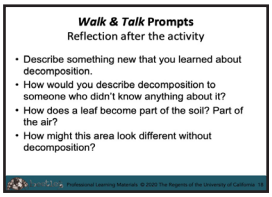
TEACHING NOTES

Interviewing students. Interviewing students one-on-one can be a powerful way to learn about student ideas and understandings as they try to communicate these in their own words. *Walk & Talk*, *Turn & Talk*, and other paired discussion routines offer instructors important opportunities to conduct brief interviews with individual students to find out what and how they are thinking. If possible, it can also be useful to set up longer individual interviews with volunteer students during break time or while someone else is teaching the group. It's important during these interviews to ask broad questions, listen carefully, ask follow-up questions, and not judge answers as right or wrong in the moment. Many students enjoy having an adult paying attention to their thoughts, and the experience may be eye-opening for instructors.

About adjusting teaching activities based on feedback from different students. In outdoor science schools, instructors often teach the same activities from week to week, so what they learn from how an activity went with one group may inform how they run the same activity with the next group. It's important to not get stuck presenting an activity the same way with all groups, or assuming it will work the same way with different groups. Instructors should pay attention to each group and, as much as possible, pay attention to individuals within each group, adjusting their instruction to students' strengths and needs.

b. These are two performance tasks used in *Decomposition Mission*: the small-group decomposition displays and the individual decomposition diagrams/models.

18. Show Slide 18: *Walk & Talk Prompts: Reflection after the activity.* Explain that assessments, such as *Walk & Talk*, can be used after instruction.



slide 18

a. *Walk & Talk* is a routine that's often used as pre- and/or post-assessment embedded in instruction.

b. These are Walk & Talk reflection questions to ask at the end of Decomposition Mission.

c. If instructors listen to student responses, if they use the information to adjust their instruction, and if they encourage students to reflect on what they understand and are still struggling with, then Walk & Talk can be considered an assessment.

19. Explain that assessment prompts are an opportunity for both expanding thinking and providing evidence of student learning:

a. Assessment (or reflection) prompts at the end of instruction give students a chance to hear one another's ideas and build on them.

b. *Walk & Talk* gives an instructor opportunities to partner with and listen to individual students.

c. Instructors also get to hear from a variety of students when they're sharing out with the whole group.

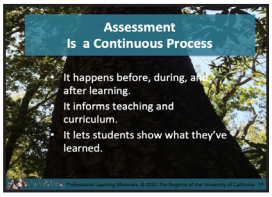
d. Post-assessments help an instructor find out what students understand after a learning experience.

e. Most importantly, *Walk & Talk* prompts after an activity help students reflect on their own learning and solidify their understanding.

20. Ask group to brainstorm other types of post-assessments and listen to their ideas:

▶ *What are other types of post-assessments that could help an instructor find out what students have learned?*

21. Show Slide 19: *Assessment Is a Continuous Process.* Explain that although some assessment is only done after instruction, assessments before and during instruction give an instructor information they can use to adjust instruction:



slide 19

a. Since student understanding is the goal of quality instruction, a thoughtful instructor s hould be constantly trying to find out what their students are thinking and understanding.

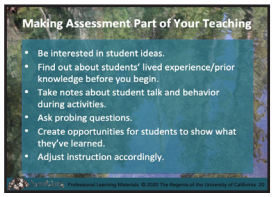
b. The best field instructors are as curious about what students are thinking as they are about the natural world they are teaching about.

c. People often think of assessment as something that's done only at the end of instruction.

d. However, after instruction, it's often too late to use the information to adjust instruction—at least with the group you have assessed.

e. Embedded assessments are important tools for instructors. They are used during instruction, while you can still make adjustments to help students learn.

22. Show Slide 20: *Making Assessment Part of Your Teaching*. Explain that these practices help instructors adjust instruction:



slide 20

a. These practices help instructors be more responsive to students' needs and enable instructors to collect feedback on how they are meeting their teaching goals.

b. Assessment helps instructors listen to students.

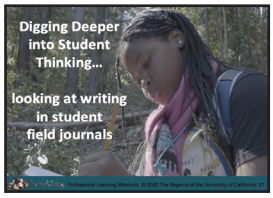
c. By listening, instructors will also learn about students' lived experiences and how they came to understand what they understand.

d. This can help instructors make their instruction more culturally relevant.

e. The main takeaway is that good instructors don't always stick to their script; they often use evidence of student thinking to be more thoughtful about decisions they make to provide the most effective learning experiences for their students.

Looking Closely at Student Work

1. Show Slide 21: *Digging Deeper into Student Thinking...* Explain that so far, we've focused on on-the-fly embedded assessments that should be part of instructors' ongoing instructional habits.



slide 21

2. Explain that now we'll shift to looking deeply at written student work to figure out what students are learning:

a. Now we'll shift to making sense of individual student's written responses to a prompt.

b. This is also considered embedded assessment although it involves taking the time to carefully look at student work.

c. We'll use a specific process for making sense of students' written responses.

d. This is probably a practice you'll use less often, because it takes more time.

e. Even if you only do it once in a while, it provides a deeper understanding about the relationship between what you teach and what students understand.

TEACHING NOTES

Breaking up this session into two parts. If you have less time available than the 3 hours and 10 minutes needed for this session, we strongly recommend against only doing some of the session; instead, break it up into two parts. The end of the Planning for Assessment section of this session is a natural intermission point for exploring the topic of assessment; the Looking Closely at Student Work portion of this session could take place at another time. Between sessions, you could ask instructors to try out different types of embedded assessments and have them be prepared to report back on how it went.

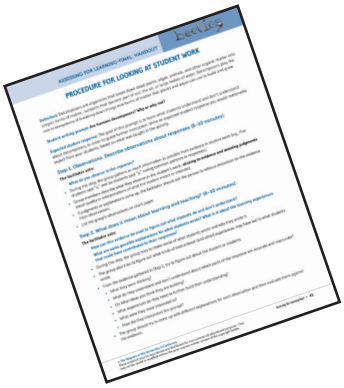
YOU ARE HERE:

50 minutes

Using your own student work samples. If you have collected written student work from your own program, make copies and use it for this session instead of the student work provided here. To have a meaningful discussion about student thinking, try to choose samples that show a variety of responses to a broad question. If all students answer in the same way, there's not much to talk about or interpret. Interesting responses from 6–10 students provide enough material for plenty of interpretation and discussion. The goal is to stimulate an in-depth discussion about student thinking.

TEACHING NOTES

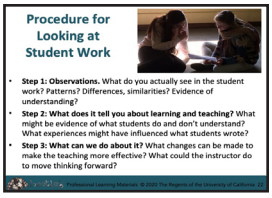
What kind of assessment is the writing prompt? It depends on how you use it. If you use it during teaching and employ information from it to adjust your teaching, then it's an embedded (or formative) assessment, which is how we suggest using it. If it's used to assign grades or to report to teachers on what students learned, then it is a summative assessment.



Understand the importance of adhering to the guidelines for discussion. You may find that your staff is resistant to sticking with the three phases of discussion about student work. Emphasize that these guidelines were developed through extensive experience with educators involved in in-depth analysis of student work, with the goal of improving instruction to support student learning. Remind your staff that delaying their conclusions until they've discussed all the evidence and its possible explanations is in line with a scientific approach to investigating student thinking. Going through the process will slow things down and help instructors avoid their own assumptions and unconscious biases about students.

3. **Explain that examining and discussing samples of student writing is helpful to uncover how students struggle with understanding and how we can improve their instruction:**
   - **a.** We're about to dig deeper into student thinking by examining individual responses from students' field journals.
   - **b.** Instructors can gain the most from looking at how their own students respond, but we're going to look at sample student responses to learn a process for engaging in discussions about student learning.
   - **c.** Our goal is to get insights about the challenges of understanding what students are learning.
   - **d.** Another goal is to learn how we can make adjustments to instruction to support student learning.

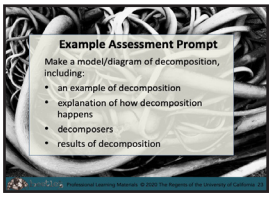
4. **Show Slide 22: *Procedure for Looking at Student Work*. Distribute the handout and explain that instructors will use this procedure to look at student work.**



slide 22

   - **a.** Distribute one copy of the *Procedure for Looking at Student Work* handout to each participant.
   - **b.** Explain: In small groups, you'll use the process described on the handout to examine a set of student responses together.

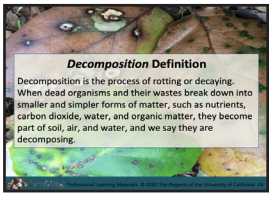
5. **Show Slide 23: *Example Assessment Prompt*. Explain the example prompt:**



slide 23

   - **a.** We'll work through an example together in order to explain the procedure.
   - **b.** After the example, you'll look at student work from a different assessment prompt.
   - **c.** For the example, we'll look at three student responses from the model of decomposition made by students during *Decomposition Mission*.
   - **d.** The prompt for the task was to make a model/diagram of decomposition, including:
     - an example of decomposition
     - an explanation of how decomposition happens
     - decomposers
     - results of decomposition

6. **Show Slide 24: Decomposition *Definition*. Explain that a definition like this can be used to plan instruction and later, when analyzing assessments.**



slide 24

   - **a.** This is the definition of decomposition used in *Decomposition Mission*.
   - **b.** A definition like this is useful when planning instruction and analyzing assessments.

c. During an outdoor science experience, students would not necessarily be expected to fully understand this whole definition.

d. Depending on how much time an instructor has for the topic—and the age, experience, etc. of students—they might choose certain parts of the definition on which to focus instruction.

7. Explain why looking at student work is structured:

a. The reason the conversation will be structured is to keep the focus on evidence of student learning and on implications for instruction. The structure (often called a protocol) encourages instructors to be reflective and to productively discuss ideas with their peers.

b. In science activities (and many aspects of life!), learners often leap to conclusions, confusing their interpretations with fact or evidence.

c. This can also happen when instructors look at student work.

d. The guidelines help instructors:

- Avoid inferring too much and jumping to conclusions.
- Aviod criticizing the teaching or the students.
- Be more aware of the biases.
- Stay focused on how to use this information to adjust their instructions.

8. Explain why it's important to stick to the evidence during Step 1: Observations (from *Procedure for Looking at Student Work* handout):

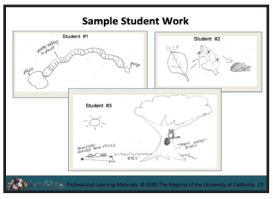
a. You'll spend the first 8–10 minutes *only describing what you see* in student responses.

b. You'll describe what students are actually communicating through drawings or writing—*not what you think they mean or why you think they wrote what they wrote*!

c. You'll also describe patterns; the range of responses; or any specific use of vocabulary, differences, similarities, etc.

d. At this stage, it's important to stick to observations and avoid explanations.

9. Show Slide 25: *Sample Student Work*. Run through one example of student work together. Ask participants to describe observations of patterns they notice in student work.



slide 25

a. Tell participants you're going to run through an example of student work together to practice the protocol.

b. Ask participants to point out observations of patterns in these three responses.

c. Consider adding some of the following observations, if they haven't mentioned them:

TEACHING NOTES

During Step 1 (from *Procedure for Looking at Student Work* handout), participants only talk about observations! During Step 1, it's important that instructors stick strictly to observations and not drift into explaining. *None of the students included gas in their drawings.* is an observation, and *Maybe students don't understand how gas is a part of decomposition.* is an explanation based on that observation. We all make observations and explanations every day. This can be problematic when we confuse the two without recognizing which is the observation and which is the explanation. Stay with observations and resist the temptation to make explanations! By keeping the discussion focused on generating observations of student work, instructors become familiar with distinguishing observations from explanations.

During Step 2 (from *Procedure for Looking at Student Work* handout), participants keep everything grounded in the evidence! During Step 2, instructors do make explanations, but these need to be firmly grounded in the evidence. It can be harmful when our explanations drift away from the evidence and toward assumptions and unconscious biases. It's best to consider a variety of explanations and not just the first one we come up with. We should be open to the possibility that our explanation(s) may be inaccurate, which is why it's important to use language of uncertainty. Instead of saying, "Students don't understand how gas is a part of decomposition," we begin the statement with language of certainty, such as, "Maybe...," "Perhaps...," or "Based on the evidence, it looks like...."

TEACHING NOTES

The process of assessment is similar to science. In science, observations are gathered, used as evidence in explanations, and described by using language of uncertainty to indicate openness to other evidence and explanations that may emerge. Multiple explanations are considered, and it's important to be careful to distinguish explanations from observations. Similarly, in assessment, data are gathered about student learning and are used as evidence to support explanations about learning and teaching; it's important to maintain uncertainty because it's impossible to have certainty about anything that's going on in students' heads.

- All examples are terrestrial (this observation is used below in the example in Step 2).
- All include the four requirements in the prompt.
- All show eating.
- Two (maybe three) include poop (Students 1 and 3).
- One (maybe two) includes dirt (Students 2 and 3).
- None show matter breaking down into smaller and simpler parts.
- None include gases or water.
- All show plant matter being eaten, not animal matter.
- Two don't include living plants (Students 1 and 2).
- One shows plant matter as part of a system (Student 3)
- All decomposers shown are animals.

10. Explain that during "Step 2: What does it mean about teaching and learning?" (from *Procedure for Looking at Student Work* handout), they will try to make sense of their observations but need to keep explanations grounded in evidence.

a. This step is about trying to figure out what your observations mean.

b. You'll spend 8–10 minutes thinking about how students came to say what they said.

c. What observations might be evidence of what students do and don't understand?

d. You'll think about what experiences might have influenced what the students wrote, and what it may indicate about their understanding of decomposition.

e. You'll think about what their writings may say about the instruction they've had.

f. You'll also think about how closely the prompt is aligned with your learning goal.

g. Try to come up with multiple explanations of each observation. This will help you to be generative and to try to get inside the head of your learners so you don't get stuck in your own perspective.

h. Make sure your explanations are tentative and based on the evidence.

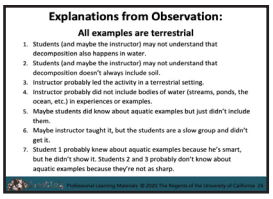
i. As with science, everything should be grounded in the evidence!

11. Choose one observation and get the group to come up with different explanations of it. Explain:

a. Let's take an observation: *All examples are terrestrial.* (Note: This is an observation of a pattern, not of an individual response.)

b. What are some explanations you can make about the learning and instruction that occurred, based on this observation? (Listen to a few ideas and ask follow-up questions, as appropriate. For each one, make sure they share how it is grounded in the observation.)

12. Show Slide 26: *Explanations from Observation: All examples are terrestrial.*



slide 26

a. When making explanations based on student work, it's important to keep explanations grounded in the observations.

b. Here are some possible explanations that might be made from the observation that all examples in the student work are terrestrial:

- Students (and maybe the instructor) may not understand that decomposition also happens in water.
- Students (and maybe the instructor) may not understand that decomposition doesn't always include soil.
- Instructor probably led the activity in a terrestrial setting.
- Instructor probably did not include bodies of water (streams, ponds, the ocean, etc.) in experiences or examples.
- Maybe students did know about aquatic examples but just didn't include them.
- Maybe instructor taught it, but the students were a slow group and didn't get it.
- Student 1 probably knew about aquatic examples because he's smart, but he didn't show it. Students 2 and 3 probably don't know about aquatic examples because they're not as sharp.

13. Say that explanations with smaller assumptions are more reliable and ask which of these seem to have smaller assumptions:

a. The most reliable explanations involve the least amount of interpretation.

b. Another way to describe it is that more reliable explanations involve smaller assumptions.

c. Explanations that involve more interpretation/larger assumptions are less reliable.

d. Which of these seem to involve more interpretation or less interpretation? (Listen to their ideas and ask follow-up questions, as appropriate.)

14. Explain that some interpretations and assumptions can be harmful:

a. Some interpretations and assumptions can be harmful.

b. #6 and #7 in this example are potentially harmful interpretations.

c. Although it's possible that #6 and #7 are accurate, they may not be.

d. They may reflect unconscious bias or stereotypes on the part of the instructor and may be unfair to students.

e. The problem with unconscious biases is that we all have them, but we don't know we have them.

f. One way to become more aware of our unconscious biases is by thoughtfully examining our explanations and interpretations.

TEACHING NOTES

Is the assessment for the instructor or for your program? Much of this session is directed at instructors conducting assessment to improve their instruction. Assessment can also be used by you and your staff to assess the impact of a particular part of your program or to improve an activity your whole staff teaches. Perhaps there's an important goal your program has, and you want to find out if you're meeting it by learning what students are actually walking away with. Or maybe you have an activity your staff teaches to many groups of students, and you want to find out how effective it is. If that is the case, it could be worthwhile to have your staff, or a smaller team, come up with an assessment, use it with students, analyze the results, and then make adjustments accordingly. Whether an assessment is for an individual instructor or for your program, time needs to be set aside after analyzing the results to implement any desired changes. If an instructor is reading student responses in order to adjust their teaching, they'll need time to plan for next steps and to implement changes. If the purpose of the assessment is to think about revising an activity or assessing the impact of your program, you'll need time for your team to think about the broader programmatic implications.

Assessment-influenced changes in *Decomposition Mission*. Lessons learned from assessing students' understanding during and after their participation in *Decomposition Mission* inspired BEETLES to rewrite the activity. We realized students weren't understanding the role of decomposers in an ecosystem and that they needed more support for understanding the concept of breaking down things into smaller and simpler parts.

TEACHING NOTES

It's challenging to explain a no-response or a weak response. Students might give a weak response or no response at all because they don't understand the content or the question. Students who struggle with writing skills may not be able to fully communicate their thinking through writing. A student who is not engaged by the assessment activity or doesn't feel invested in responding may respond in a way that doesn't reflect their actual learning.

Equity and assessment. Historically, standardized assessments in the United States have been found to be biased toward white and economically advantaged students. Cultural biases, language, and different expectations teachers have for students of various races or social classes can all unfairly affect student performance (Kim & Zabelina, 2015; Berlak, 2000). To make assessments more equitable, the prompt/task/question should be based on information and experiences that all your students have access to and should be relevant and interesting to them. In outdoor science, assessments are ideally based on a common engaging experience in which the group has participated. Vocabulary can be a barrier to understanding how to respond, so use language accessible to all students. Any difficult words should be used extensively and in context beforehand. Students who have more experience with test-taking may be better at figuring out how to be successful on the assessment, so it's important to be clear about your expectations for responding so all students will know how to respond.

g. By trying to stick to explanations with less interpretation, we can limit the influence of our assumptions and biases.

15. Explain that during "Step 3: What can we do about it?" (from *Procedure for Looking at Student Work* handout), they will discuss next steps for teaching:

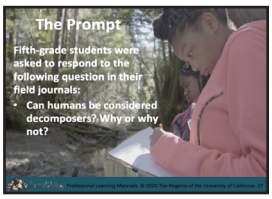
a. For the final 8–10 minutes of the small-group time, you'll discuss instructional implications.

b. You'll brainstorm next steps for modifying the way the lesson might be taught next time.

c. You'll also think about what follow-up experiences could help these students deepen their understanding.

d. As an instructor, how might you shift instruction to address the example: *All examples are terrestrial?* (Listen to a few of their ideas.)

16. Show Slide 27: *The prompt...* Explain the context for the writing assignment:



slide 27

a. That was just an example.

b. Now we'll switch over to the prompt you will actually be examining.

c. Fifth-grade students were given this writing prompt after experiencing the *Decomposition Mission* activity.

d. They had been thinking about decomposition and its role in ecosystems.

e. They also had time to discuss the question in small groups before writing.

17. Ask instructors to take a few minutes to individually write an expected student response to this question:

▶ *Can humans be considered decomposers? Why or why not?*

a. A definition of *decomposers* is at the top of your page.

b. Think about what part of that definition students had the opportunity to learn during *Decomposition Mission*.

c. The purpose for writing an expected student response is to clarify what you think an optimal response from a student will look like.

d. In general, it's good practice to try out your prompts for students by writing an expected student response to ensure that the question is understandable and that students have had the opportunity to learn the concept.

e. Write an expected student response based on what was taught in the activity.

18. Ask instructors to share and compare some of their expected student responses:

a. Have two or three instructors read their expected student responses.

b. Are they similar to one another?

c. Was it easy or hard to come up with a student response? Why?

19. Explain that small groups will examine student work together for 25–30 minutes, and a facilitator will keep track of time:

a. Choose one person in your group to be your facilitator.

b. The facilitator will keep the group on task and stick to the time frame for the different phases of your discussion.

c. Choose another person to record the group's observations, reflections, and next steps for teaching.

d. You'll have 25–30 minutes to examine the student work and record ideas from your discussion.

e. You'll also be making a poster showing your summary thoughts.

20. Distribute student work, chart paper, and markers to groups of four.

a. Distribute a set of student work to each group of four.

b. Distribute chart paper and markers to each group.

21. Groups examine student work and summarize discussion on chart paper.

a. Circulate to check in with each group to see how they're doing with their analysis and recording their discussion.

b. Remind facilitators to keep moving the group through the three stages of the discussion every 8–10 minutes.

c. Give a time check for the last 8–10 minutes of their discussion and let them know that they'll be sharing out their ideas for making changes and additions to instruction.

Discussing How to Use Evidence of Student Learning to Improve Instruction

1. Bring the whole group back together. Lead a whole-group discussion about the student work:

a. Ask each group to put their poster on the wall where it's visible to all.

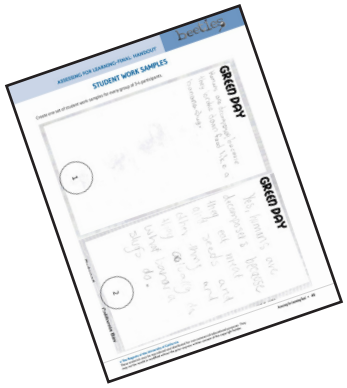
b. Ask participants the following questions to facilitate the discussion:

- *What was interesting or surprising about the student ideas?*
- *What questions about teaching decomposition did this raise for you?*
- *How might you use these student responses to improve instruction?*
- *What was the process like of examining student work?*
- *How could you find out more about what's behind some of the responses?*

c. Mention the following if they haven't already been brought up:

- Ask students to explain their thinking.
- Research common misconceptions about the topic.

TEACHING NOTES



YOU ARE HERE:

10 minutes

TEACHING NOTES

Instructor bias self-assessment. We all have unconscious biases that influence our instruction, as when teachers call on more boys than girls. Research confirms that teachers frequently call on boys more often than girls, accept more called-out responses from boys than girls, give boys more wait-time to respond, and give boys more praise and remediation than girls (Sadker & Sadker, 1994; Biklen & Pollard, 1993). Teachers usually are not aware that they favor the boys in their classroom over girls and are genuinely surprised when they learn of these inequities when they confer with trained observers or watch videotapes of their teaching (Wellhousen & Yin, 1997). We can't completely eliminate our biases, but by becoming more aware of them, we can be more equitable when we teach. Below are resources for instructors to use to become more aware of their unconscious biases.

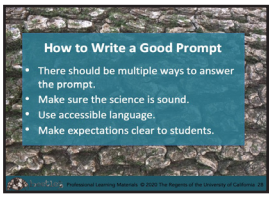
The Avarna group has a free resource *Instructor Bias Assessment* (https://theavarnagroup.com/wp-content/uploads/2017/04/Instructor-Bias-Self-Assessment.pdf) for instructors to use to check their own unconscious biases. The Teaching Tolerance website has an article on biases, as well as a link to the Project Implicit online test that individuals can take to reveal hidden biases: Test Yourself for Hidden Bias (https://www.tolerance.org/professional-development/test-yourself-for-hidden-bias).

Zaretta Hammond's book, *Culturally Responsive Teaching and the Brain*, has a chapter titled "Preparing to Be a Culturally Responsive Practitioner," which walks the reader through unpacking their own biases and other challenges that may interfere with working with students from different backgrounds, races, classes, languages, or genders.

2. **Explain that when you are the instructor, you can focus on how you taught and how you might improve your teaching:**
   - **a.** In this case, you were examining work by students taught by an instructor other than yourself.
   - **b.** When it's your own instruction, it may be harder to admit when student confusion, lack of understanding, or misconceptions were influenced by the way the activity was taught.
   - **c.** Alternatively, you may be harder on yourself than you need to be.
   - **d.** As instructors, what we primarily have influence over is how and what we teach, so it's useful to focus on how we can improve our practices for each group of students.

3. **Explain that it's easy for unconscious biases to influence your interpretations:**
   - **a.** It's easy for your unconscious biases to influence your interpretations.
   - **b.** When we expect more or less from some students than others and are not conscious of it, we may unfairly assess our students.
   - **c.** Keeping explanations grounded in observations and staying away from large assumptions helps minimize this.
   - **d.** Examining our own unconscious biases is also important for instructors to do.

4. **Show Slide 28: *How to Write a Good Prompt*. Explain that you'll give some helpful hints for writing student prompts:**
   - **a.** Following are important reminders for creating productive writing (or discussion) prompts.
   - **b.** They're also on the handout.



slide 28

5. **Explain that there should be multiple ways to answer your prompt:**
   - **a.** Asking broad questions allows students to show their thinking.
   - **b.** It also generates divergent ideas about a topic.
   - **c.** A wider range of responses gives the instructor more information about different ideas that students may be holding and uncovers more options about what to do next.
   - **d.** Example: If you ask students to identify three types of decomposers (a narrow question) and most students say, "Fungi, bacteria, and invertebrates," it doesn't give you evidence of how they're making sense of decomposers and their role in ecosystems. Instead, try asking, "Describe a decomposer and the role it plays in an ecosystem."

6. **Explain that the science has to be sound:**
   - **a.** Sometimes, the way a question is asked can perpetuate misconceptions or inaccurate ideas.
   - **b.** Example: Asking students to describe how decomposers provide food for plants might contribute to the incorrect idea that nutrients are food

for plants, rather than the idea that they are essential chemicals that plants need to make food for themselves through photosynthesis.

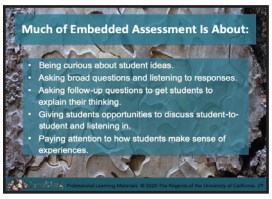
7. **Explain that the language needs to be accessible:**
   a. Double-check that the way the question is written is clear to all your students. One way to check is to try to write a response yourself!
   b. Don't use jargon, complicated words, or phrasing they may not understand.
   c. Important difficult words should be included, but you need to use them several times in context during instruction before you use them in an assessment prompt.

8. **Explain how to make expectations clear to students:**
   a. If students are unclear about your expectations for their responses, they may not include what you're looking for.
   b. Tell students you want them to explain their thinking and then describe ways in which they can make their thinking understood, such as by making a diagram or model.
   c. For example, if you want them to refer to evidence from their investigations, then you should specifically ask them to do so.

9. **Explain that even with imperfect prompts, you can learn a lot from student work; with experience, you will get better at writing prompts:**
   a. Sometimes what you learn from student work is that your prompt wasn't good enough to get student responses worth analyzing.
   b. No assessment prompt is perfect, including the one we featured.
   c. Still, this set of authentic student work was useful for engaging in an analytical discussion about teaching and learning.
   d. By engaging in this kind of process and revision of prompts, we can develop better, more fruitful questions to use with students.

Wrapping Up the Session

1. **Show Slide 29: *Much of Embedded Assessment Is About.* Explain that embedded assessment integrates the asking of probing questions and listening to students as an ongoing practice into your instruction:**



slide 29

   a. Much of embedded assessment is about:
      - Being curious about students' ideas and finding windows into their minds.
      - Asking broad questions that have many acceptable responses and listening to students' ideas.
      - Asking follow-up questions to get students to explain their thinking and to better understand their ideas.

TEACHING NOTES

Why analyze assessments?

- **It informs learning goals.** It helps us improve our decisions about how to help students learn and helps us make the content more appropriate for the grade level as well as more scientifically accurate.
- **It informs instruction.** It helps us improve how we're teaching and helps us understand what works well and what we can change to better support student learning.
- **It informs future assessments.** It provides information to revise the assessment method or tool to collect better evidence of students' understanding.

YOU ARE HERE:

10 minutes

Refer to Questioning Strategies session as appropriate. If you have already presented the BEETLES Questioning Strategies professional learning session to your instructors, take this opportunity to refer back to the benefits of asking broad questions versus narrow questions.

TEACHING NOTES

"I managed good but, boy, did they play bad!"—Rocky Bridges, minor league baseball manager. Many instructors, when they look at student work, are surprised to find that their students didn't learn everything they taught. It's easy to assume that because we taught something, it's the learner's fault if they didn't learn it or that the student work just doesn't capture what students learned. It's just as easy for instructors to get discouraged and assume they must be terrible teachers. It takes confidence and courage for instructors to look objectively at student work and acknowledge that they are helping students and that they need to keep struggling to provide students with better and more meaningful learning experiences that will stick. Be sure to support your instructors when they have the courage to tell you, "Ugh! I taught about decomposition for two hours, and my kids didn't learn anything!"

- Giving students opportunities to have student-to-student discussions and listening in on their discussions.
- Paying attention to how students make sense of their experiences.

2. The purpose of embedded assessments is to help the instructor make ongoing adjustments to instruction, based on what they observe about student understanding.

a. The best instructors don't teach in the same way to all students.

b. They make ongoing adjustments to instruction, based on what they learn about student understanding through embedded assessments.

3. Explain that you can equip yourself to be more flexible as you learn about your group's understandings:

a. As you're teaching a group and learning through embedded assessments about their understandings, it's good to be flexible and adjust your instruction for that group.

b. There are ways you can prepare yourself to be better equipped to make adjustments in instruction.

c. It takes practice to make decisions based on student understanding and to adjust your instruction and curriculum accordingly.

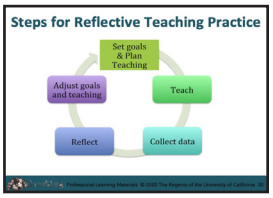
4. Suggest being strategic in assigning and collecting in-depth written assessments. Explain:

a. The analysis of student work we just did takes time, so it's probably not something you'd do every day or even every week.

b. When do you think it might be especially helpful to collect and analyze student work (e.g., when kicking off staff discussion about student learning, when teaching about a particularly complex idea, when trying out new approaches to instruction, when taking a mid-week checkpoint)?

c. If you don't have much time, you can pick one or two students to focus on and analyze only their responses in order to get a sense of what those students may be getting out of activities and experiences.

5. Show Slide 30: *Steps for Reflective Teaching Practice*. Explain a method for being reflective about your teaching practices:



slide 30

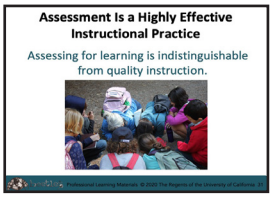
a. Assessment should be part of an instructor's ongoing reflective practice:

- **Set goals and plan teaching.** First, set a specific teaching goal for your activity or field experience, such as leading a concept-based discussion that helps students build on one another's ideas.
- **Teach.** Teach the activity.
- **Collect data.** Jot down brief notes as students are talking in order to capture some of what comes up during discussion. Assessment is collecting data about learning.

TEACHING NOTES

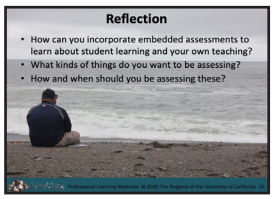
- **Reflect.** Afterward, sit down (ideally with a colleague) and think about what students were doing and what this might mean for your teaching: Are there any patterns? What do you want or expect your students to do differently? What can you do to make this happen?
- **Adjust goals and teaching.** Use what you've learned to make adjustments to improve your instruction.
- Use this cycle over and over to build expertise in instruction and assessment.

6. Show Slide 31: *Assessment Is a Highly Effective Instructional Practice*. Explain that Instructors who are skilled at teaching are constantly assessing their students and making adjustments to instruction.



slide 31

7. Show Slide 32: *Reflection*. Ask participants to reflect on what they learned from the session. :



slide 32

a. Reflect on the different assessment methods modeled in the session.

b. Write about how you might use embedded-assessment strategies to improve your teaching.

c. What should you be assessing? What are the things you care most about and that you want students to learn the most about?

d. How and when do you want to be assessing these things?

e. You may want to refer to the handout to jot down ideas about ways you can assess students in the field.

f. As they reflect, distribute the *General Practices for Using Assessment to Improve Teaching and Learning* handout

APPLYING SESSION TO INSTRUCTION

The session is not over! A critical phase of learning anything new is application—when the learner takes new knowledge and applies it. There is some application included in the session; however, as with all professional learning for instructors, the rubber meets the road (or trail) when the instructors apply what they've learned to their instruction and when they keep thinking about it and discussing it with their peers. If you want your instructors to try out new activities/approaches, program-leader support is crucial. Even if they're excited by new ideas, it's easy (especially for veteran instructors) to keep doing what they have been doing and not try out new activities/approaches for which they're not as skilled. Below are a variety of follow-up activities and discussions to dig deeper into the topic and to help you facilitate thoughtful implementation.

- **Staff brainstorm of what they and you can do to encourage incorporation of discussion strategies.** In the session reflection, your staff recorded ideas they have about implementation into their instruction. You can tap into these and other ideas through a brainstorm of what they plan to do and how you can support them in doing it.
- **Staff discussion about how you teach decomposition.** Although the subject of this session is assessment, all the examples in the session were related to teaching and understanding decomposition, which can get instructors thinking about this topic, too. After the session, you might want to have instructors work individually, in pairs, and/or with the whole group at reimagining how they teach decomposition.
- **Analyzing student work with your staff.** Now and then, ask an individual field instructor to bring a set of written student responses to a prompt for your staff to analyze, using the same discussion structure featured in this session. You might also have a group of instructors collect student work related to the same prompt to analyze together. This is a great way to get instructors to be more reflective in their practice and to cultivate a learning community among your staff.
- **Interview individual students.** Encourage instructors to set up times to interview volunteer students about a concept (such as decomposition) during break time or when someone else is leading a group. It's important during these interviews to ask broad questions, to listen carefully, to ask follow-up questions, and to not judge answers as right or wrong in the moment. Many students enjoy having an adult pay attention to their thoughts, and sometimes the experience can be eye-opening for instructors. This can also be a valuable exercise for program leaders.
- **Print out and discuss *Assessment for Learning: 10 Principles* poster.** Print out the PDF file for your staff (http://www.hkeaa.edu.hk/DocLibrary/SBA/HKDSE/Eng_DVD/doc/Afl_principles.pdf), assign pairs or small groups to read through and discuss each component of assessment shown on the diagram, and then share out in the whole

group. You might then want to post it in your staff prep room to refer back to.

- **Read and discuss about stereotype threat.** The book *Whistling Vivaldi and Other Clues to How Stereotypes Affect Us*, by social psychologist Claude Steele, is a very accessible read about stereotype threat and the underperformance of minority students in higher education. "Stereotype threat widens achievement gap" (American Psychological Association, 2006) is a short article on the topic. Assign staff to read the article or the first chapter of Steele's book (or the whole book) and then gather as a group to discuss the implications for your teaching situations.
- **Examining our own unconscious biases.** When we become more aware of our unconscious biases, we can be more equitable in instruction, curriculum planning, and running programs. Below are resources to use to become more aware of unconscious biases.
  - The Avarna group has a free resource for educators to check their own unconscious biases, titled "Instructor Bias Assessment": https://theavarnagroup.com/wp-content/uploads/2017/04/Instructor-Bias-Self-Assessment.pdf
  - The Teaching Tolerance website has an article on biases, as well as a link to the Project Implicit online test that individuals can take to reveal hidden biases: "Test Yourself for Hidden Bias" https://www.tolerance.org/professional-development/test-yourself-for-hidden-bias
  - Zaretta Hammond's book, Culturally Responsive Teaching and the Brain, has a chapter titled "Preparing to Be a Culturally Responsive Practitioner" that walks the reader through unpacking their own biases and other challenges that may interfere with working with students from different backgrounds, race, class, language, or gender.
- **Discussing Implementation of *Mind Pie*, *Decomposition Mission*, or *Walk & Talk*.** Assign each of your staff to try one of these activities during their next student program. Then, lead a discussion of the activity at the end of the program. Here are some suggested questions on which to focus a reflection or discussion:
  - What student ideas surprised you?
  - Were you able to adjust instruction based on what you learned through embedded assessments? How?
  - What was successful about the activity?
  - What might you do differently the next time you lead it and why?
  - How have you incorporated embedded assessment into other field experiences and what ideas do you have about incorporating it in the future?

STUDENT FBI CARDS

Print out, cut out along dotted lines, and fold 1 set of cards per ~15 participants

Photo credit (clockwise from top-left): Kirill Ignatyev, Boobook48, Scot Nelson, Don McCullough, Bart Everson, Scot Nelson Monteregina (Nicole).

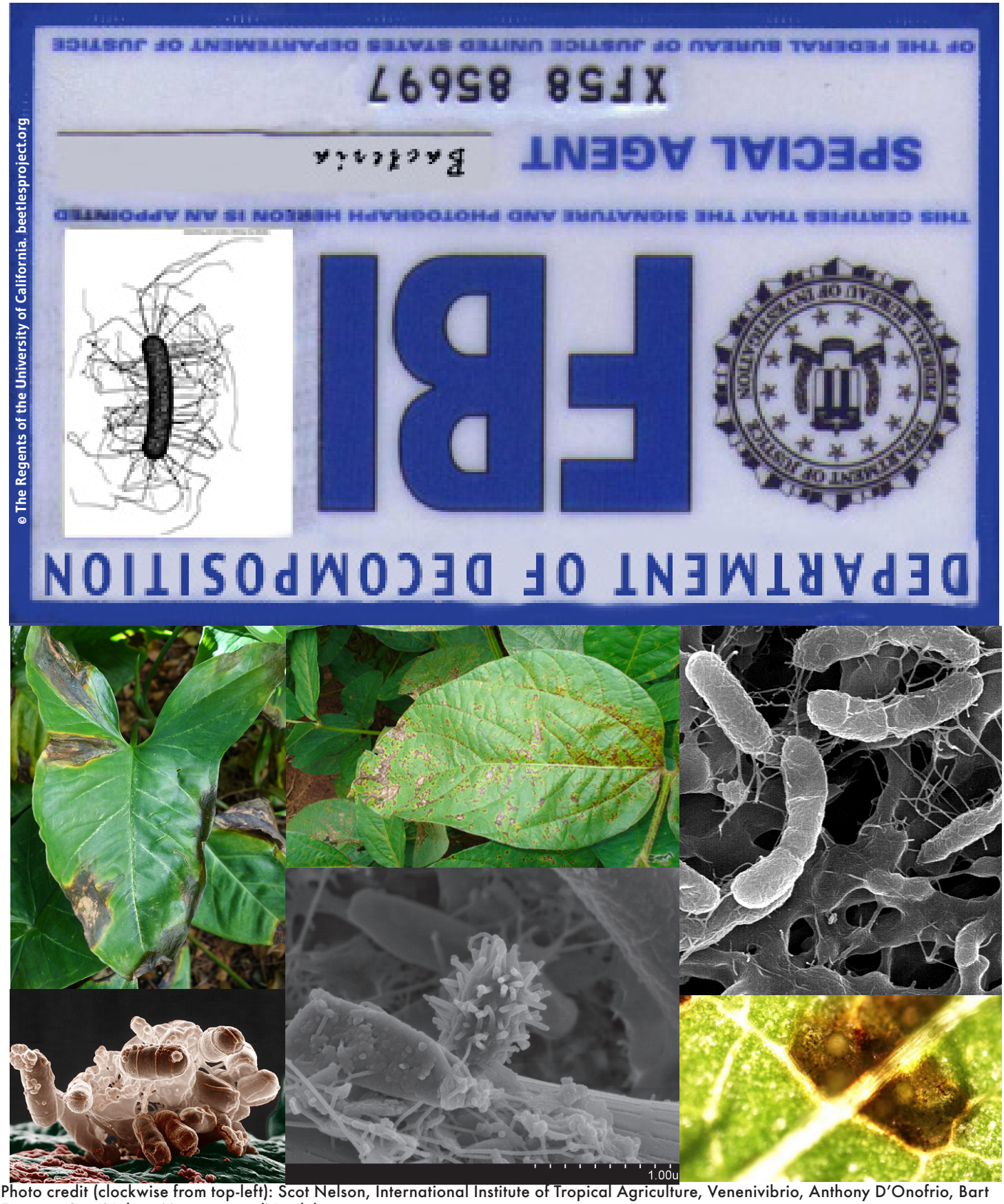


Photo credit (clockwise from top-left): Scot Nelson, International Institute of Tropical Agriculture, Venenivibrio, Anthony D'Onofrio, Bart Everson, Scot Nelson Monteregina (Nicole).

Photo credit (clockwise from top-left): Arthur Chapman, Kai Wei, Starwatcher307, Andreas Kay, Ian Morton

PROCEDURE FOR LOOKING AT STUDENT WORK

Definition: Decomposers are organisms that break down dead plants, algae, animals, and other organic matter into simpler forms of matter, nutrients that become part of soil, the air, or large bodies of water. Decomposers play the role in ecosystems of breaking down things into forms of matter that plants and algae can use to build and grow.

Student writing prompt: **Are humans decomposers? Why or why not?**

Expected student response: The goal of this prompt is to learn what students understand and don't understand about decomposers, in order to guide further instruction. Write an expected student response you would reasonably expect from your students, based on what was taught in the activity.

Step 1. Observations. Describe observations about responses (8–10 minutes):

The facilitator asks:

What do you observe in the reponses?

- During this step, the group gathers as much information as possible from evidence in student work (e.g., Five students said "x," and six students said "y," noting common patterns in responses.).
- Group members describe what they observe in the student's work, ***sticking to evidence and avoiding judgments*** about quality or interpretations of what the student meant or intended.
- If judgments or explanations come up, the facilitator should ask the person to refocus discussion on the evidence from observations.
- List the group's observations on chart paper.

Step 2. What does it mean about learning and teaching? (8–10 minutes):

The facilitator asks:

How can this evidence be used to figure out what students do and don't understand?

What are some possible explanations for what students wrote? What is it about the learning experiences that could have contributed to their responses?

- During this step, the group tries to make sense of what students wrote and why they wrote it.
- The group also tries to figure out what kinds of instructional (and other) experiences may have led to what students wrote.
- From the evidence gathered in Step 1, try to figure out about the student or students:
  - What they were thinking?
  - What do they understand and don't understand about which parts of the response are accurate and inaccurate?
  - On What ideas you think they are building?
  - What experiences do they need to further build their understanding?
  - What were they most interested in?
  - How did they interpreted the prompt?
- The group should try to come up with different explanations for each observation and then evaluate them against the evidence.

- Think broadly and creatively. Assume that the work, no matter how confusing, probably makes sense to the student. Your job is to see what the student sees.
- As you listen to one another's explanations, ask questions that help you better understand one another's perspectives.

Step 3. What can we do about it? Brainstorm Next Steps for Teaching (8–10 minutes):

The facilitator asks:

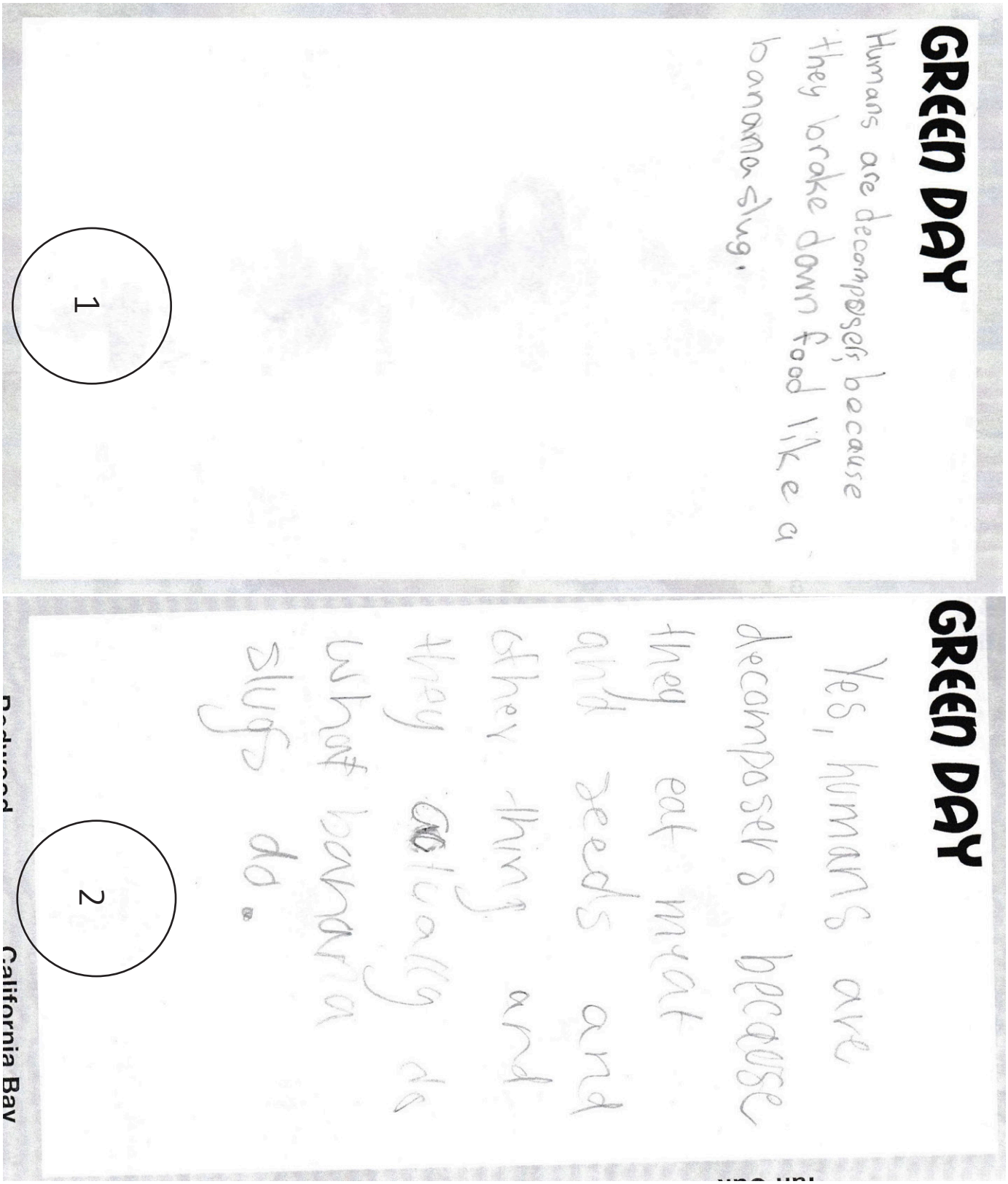
What changes can make the teaching or the lesson itself more effective?

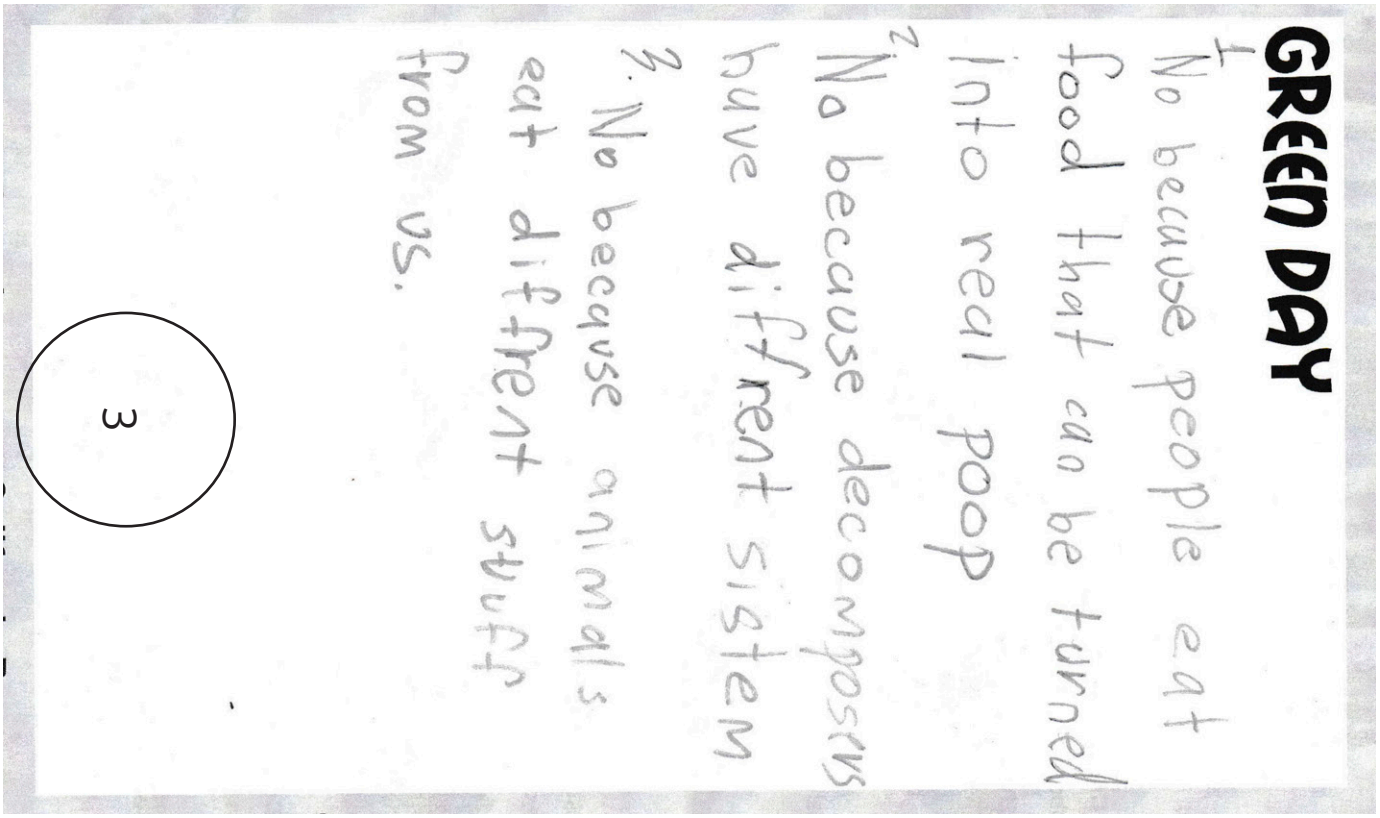
What could the instructor do to move thinking forward?

- Based on the group's observations and reflections, discuss implications this might have for teaching. In particular, consider the following questions:
  - What steps could the instructor do next with these students?
  - What teaching strategies might be most effective?
  - What else would you like to see in students' work? What kinds of activities or prompts could give you this information?
  - How might you change the learning experience or activity the next time you teach it?
  - How might you modify the prompt to improve the assessment?
  - What does this conversation make you think about in terms of your own practice?
  - How does this conversation make you think about teaching and learning in general?

STUDENT WORK SAMPLES

Create one set of student work samples for every group of 3-4 participants.





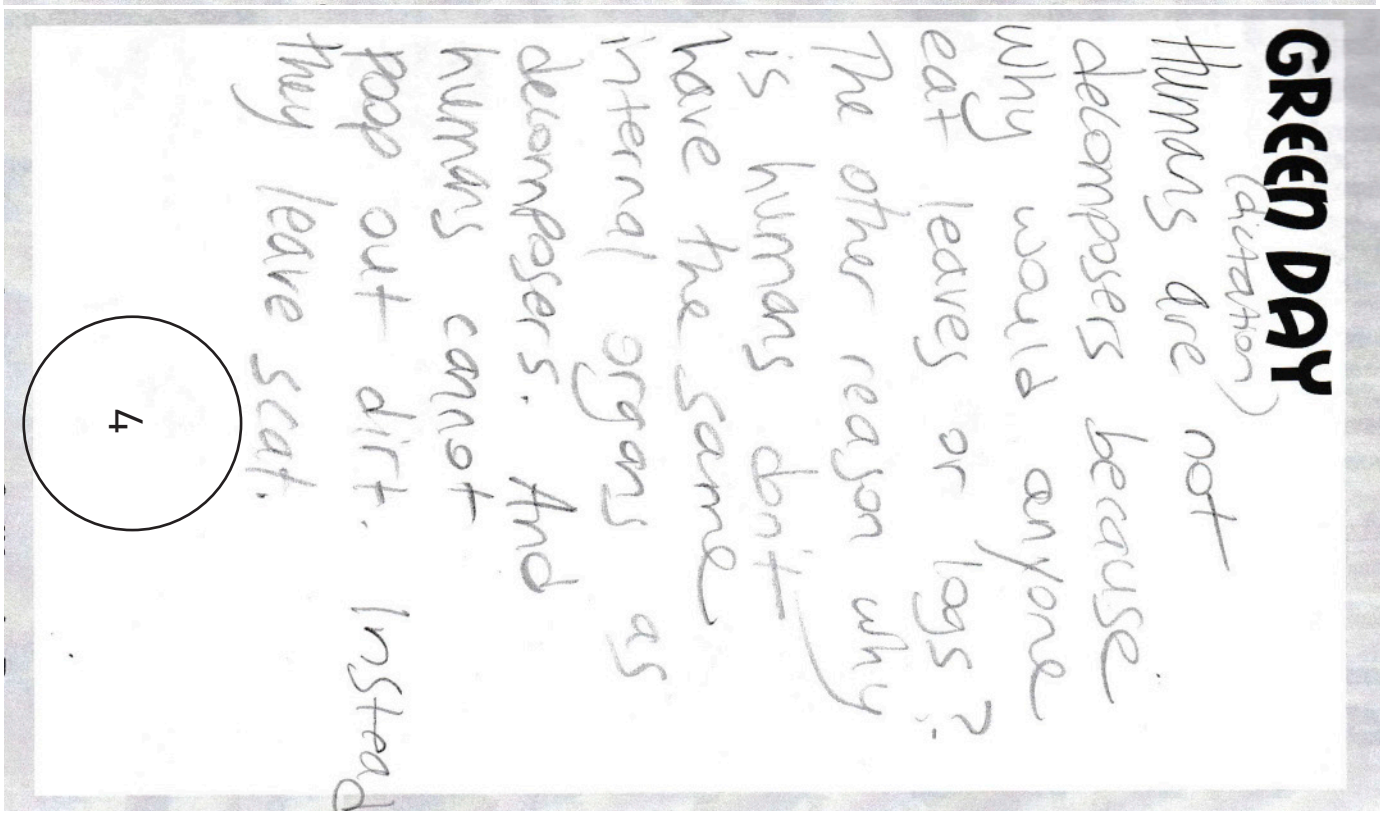
GREEN DAY

1. No because people eat food that can be turned into real poop

2. No because decomposers have different sistem

3. No because animals eat different stuff from us.

3



GREEN DAY

1. (duration) humans are not decomposers because why would anyone eat leaves or logs?

2. The other reason why is humans don't have the same internal organs as decomposers. And humans cannot poop out dirt. Instead they leave scat.

4

[illegible]

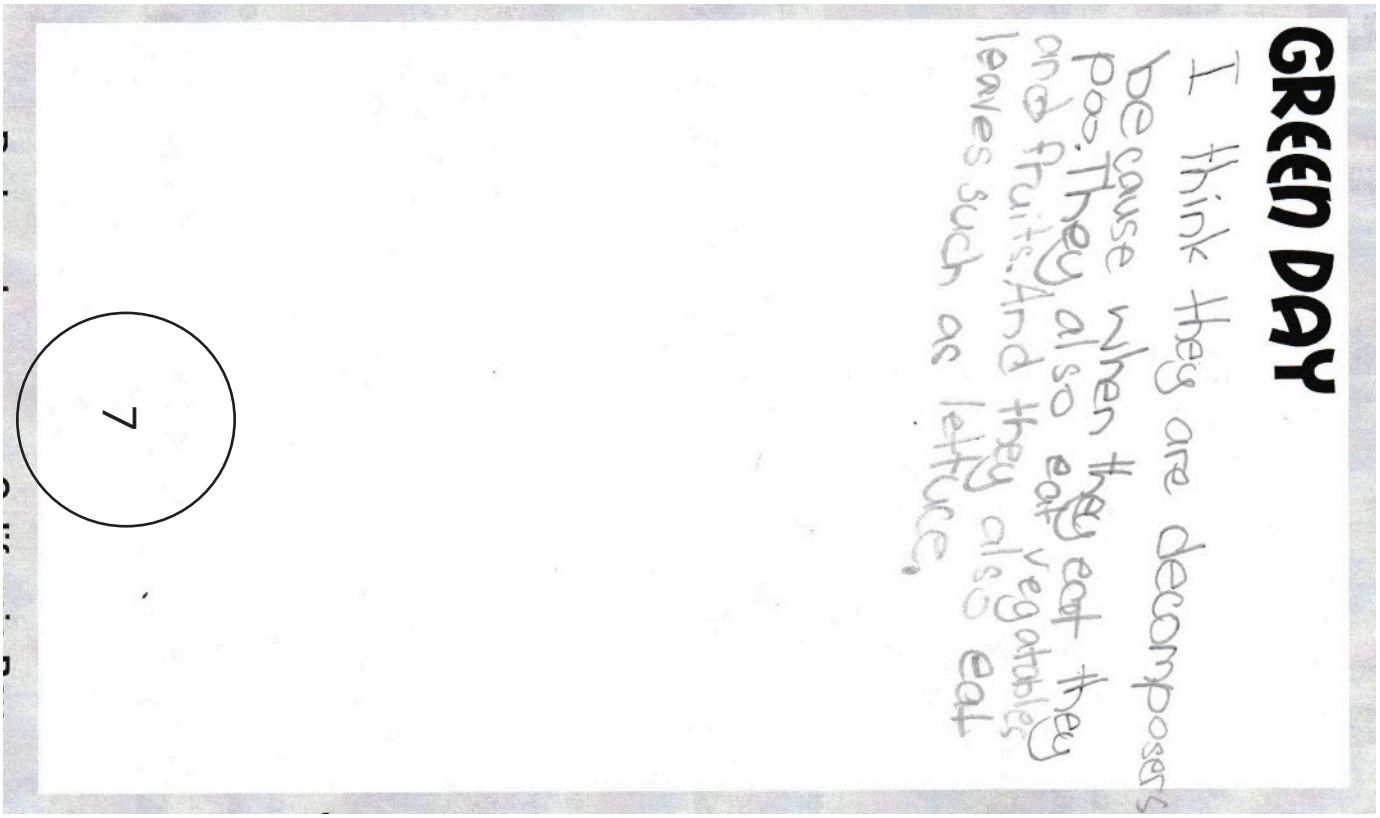
I don't think humans are decomposers When an "FBI" breaks down food the don't poop out ~~dung~~; ~~Th~~ they poop out soil like the banana slug. Humans poop dung not decomposers. What do you think.

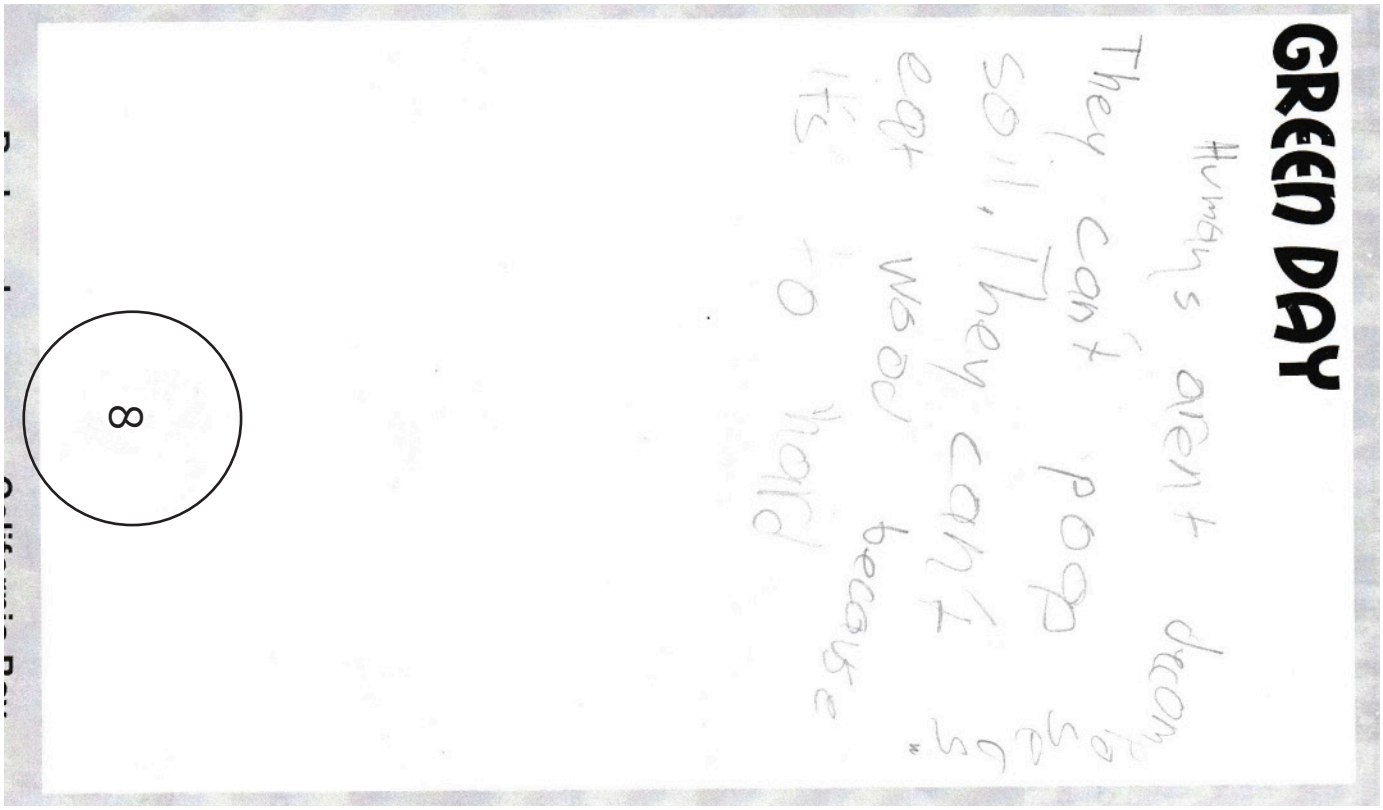
5

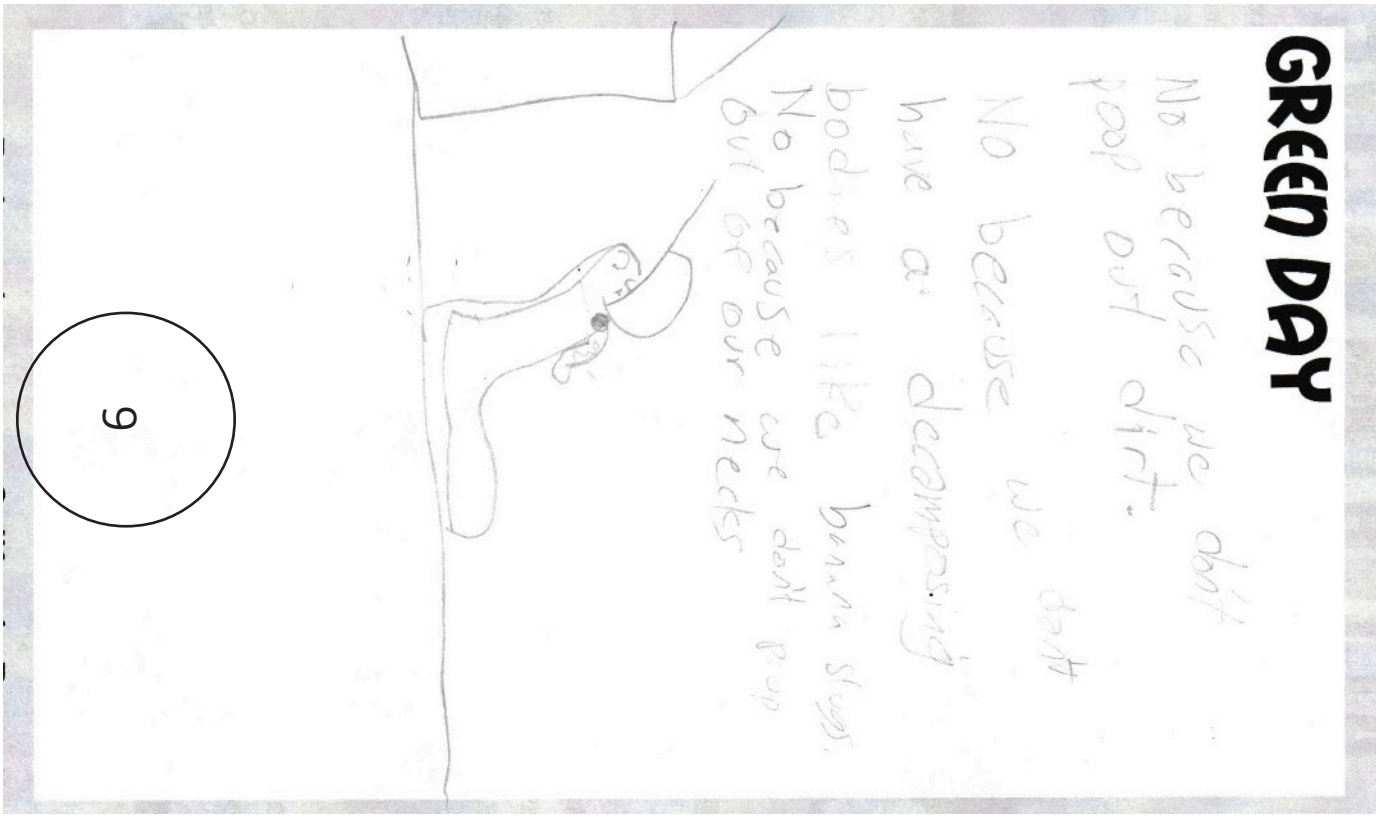
GREEN DAY

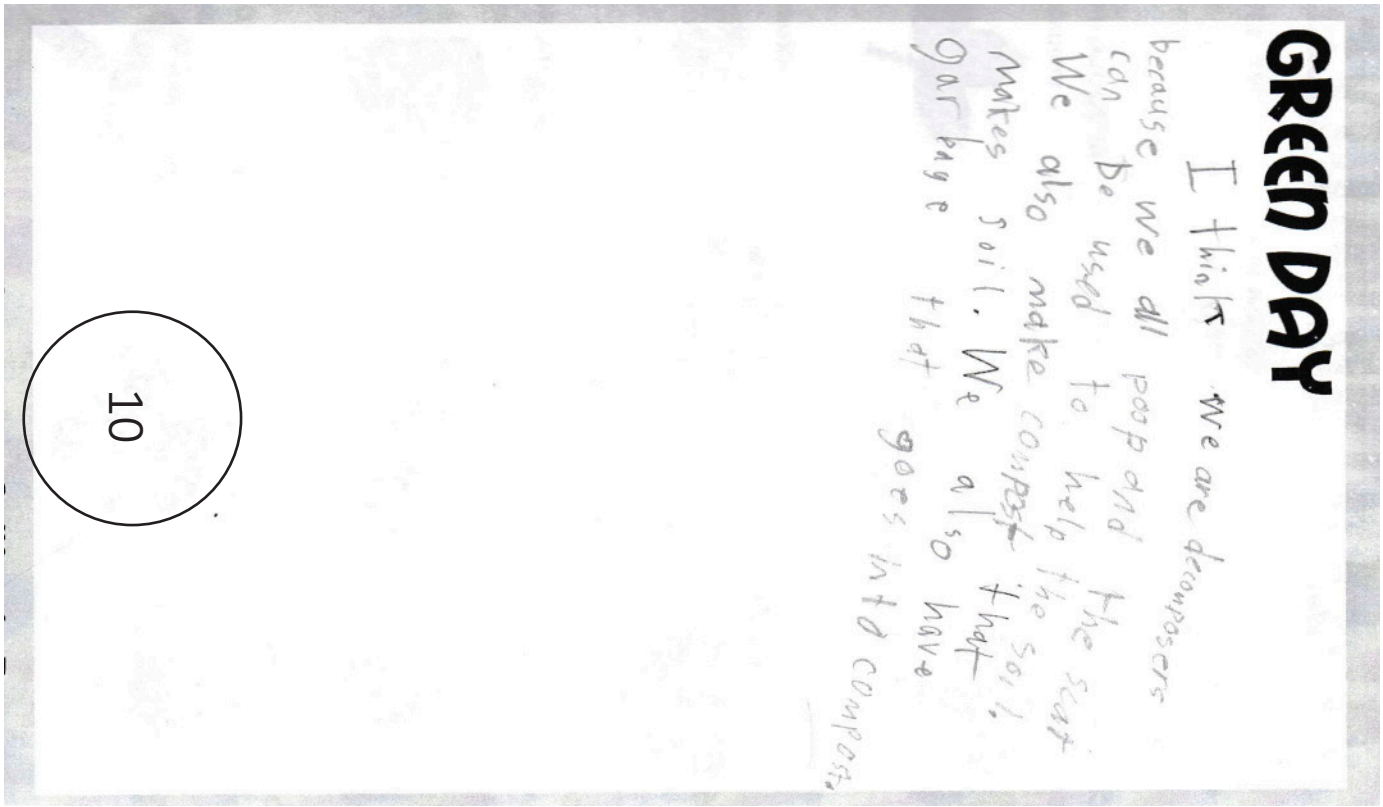
Human's are not decomposers because human's don't eat dirt. Human's Poop goes in the ocean not in the dirt. Human's don't poop outside.

6









GREEN DAY

Yes I do because we poop and so do they. We also sometime eat dead plants like them. We also walk.

11

GREEN DAY

People aren't decomposers because they can't eat random leaves.

They also can't poop dirt.

They also can't eat dead stuff.

12

GENERAL PRACTICES FOR USING EMBEDDED ASSESSMENT TO IMPROVE TEACHING AND LEARNING

(Assessing for learning should be indistinguishable from good teaching!)

Be curious about student ideas.

- Ask broad questions, give students multiple opportunities to discuss ideas, take advantage of opportunities such as *Walk & Talk* to listen to individual students, listen in on discussions and notice what students write. Encourage students to share with the group and with one another and listen to their ideas. Use your observation and inquiry skills to investigate how students develop understandings.
- Interview individual students about their ideas whenever you get a chance. One easy place to do this is during *Walk & Talk* and *Turn & Talk* activities.
- Ask probing follow-up questions. Ask students to expand on and explain their thinking. Ask, "What do you mean by that? What makes you think that?" Try to find out their reasoning.
- When students say or write "weird" ideas, ask probing follow-up questions to try to understand where they're coming from. What is the useful information or reasoning they're using? What might be leading them to inaccuracies?
- Find out what students know before you begin. Accessing prior knowledge helps students connect what they're learning to previous experiences. It also helps the instructor build on existing student ideas.
- Record student talk and behavior during activities. Jot down notes as students work in small groups. (Index cards can be handy for this.) Are there any patterns you notice? Are there common things with which your students are struggling? Can you identify any misconceptions or inaccurate ideas?

Have a variety of activities from which to choose.

- Get a series of activities on a concept (such as adaptation) under your belt and then think about and keep track of what each one offers students.
- Carry these with you and be prepared to decide which to use, depending on your assessment of where your students are at.
- See the BEETLES *Ecosystems (and Matter) Theme Hike* and *Adaptations, Structure, and Function Theme Hike* for ideas on planning progressions of activities.

Be informed about common misconceptions.

- Familiarity with common misconceptions will help you recognize them when students bring them up and can help you plan experiences to shift students' understanding.
- Read up on common misconceptions about concepts and ideas you're teaching. These are included in BEETLES student activity write-ups as Common Relevant Misconceptions in the Instructor Support section. They can also be researched online (e.g., Google "misconceptions research photosynthesis").
- When students share inaccurate ideas, try to come up with evidence/experiences that confront these ideas and help students see for themselves what's inaccurate about their ideas. Then, they can revise their ideas, which will add to their understanding.

Think about the conceptual flow for a topic you're teaching..

- Become intrigued with the conceptual flow of an area of content.
- Become actively curious about how students develop understanding of the concepts (i.e., What's a logical conceptual flow for building this understanding?).
- What are the foundational ideas students need to understand and what are the steps that go deeper?
- See the BEETLES guide, *Creating Effective Outdoor Science Activities*, pages 56–65. This section breaks down different important science concepts into an order of what students should learn about a concept and what they should understand during different grade bands. It also includes recommendations about where to focus efforts on each concept in outdoor science.

Focus on building science practices.

- Be curious about students' abilities with science practices. Pay attention to students' behaviors. At least as important as assessing conceptual understanding is assessing students' abilities to make observations, ask questions, make explanations, argue from evidence, discuss ideas with others, etc.
- Become intrigued with the progression for building students' science practices.
- What practices do students need to begin investigating the world and discussing ideas with on another? What are the steps that go deeper?
- See the BEETLES guide, *Creating Effective Outdoor Science Activities*, pages 66–74. This section includes descriptions of practices and examples of how to teach these in the field.

Explore students' "weird" ideas.

- When students say or write "weird" ideas, ask probing follow-up questions to try to understand where they're coming from.
- What is the useful information or reasoning they're using?
- What might be leading them to inaccuracies?

Adjust your teaching.

- Once you've uncovered some of what students are thinking and doing, you can make changes to the questions you ask and adjust activities and discussions accordingly
- If you notice that students seem week on a concept, you might do more with it. If students show evidence of understanding, you can take them to the next level. If students arrive with little ability to discuss ideas, focus on paired discussions and listening skills. If students arrive further along with these abilities, you can take them further in their skills.

Find out what students have learned during your instruction.

- Challenge students to apply what they've learned and push them beyond just recalling facts.
- Ask them how they might explain something they've learned to another student, using their own words.
- Lead a debrief discussion with the whole group and watch their behaviors to see what they can tell you about exploration skills, discussion skills, etc. that they've learned.

Use these steps of the Reflective Teaching cycle::

- **Set a teaching goal.** First, set a specific teaching goal for your activity or field experience, such as leading a concept-based discussion that helps students build on one another's ideas.
- **Teach what you planned to teach.**
- **Take notes.** Jot down brief notes as students are talking, trying to capture some of what comes up during discussion.
- **Reflect on how it went.** Afterward, sit down (ideally with a colleague) and explore what students were doing and what this might mean for your teaching. Are there any patterns? What do you want or expect to see your students do differently? What can you do to make this happen?
- **Adjust goals and teaching.** Use what you've learned to make adjustments to improve your instruction.
- Use this cycle over and over to build expertise in instruction and assessment.

BACKGROUND INFORMATION FOR PRESENTERS

Assessing for Learning in Outdoor Schools

Overview

Assessment of learning can be a complex and sometimes controversial topic. Assessment is an essential part of education—to gain insight into both students' learning progress and whether teaching strategies are appropriate and effective. Grant Wiggins, a leading commentator on issues in educational assessment, notes that the root of the word *assessment* comes from *to sit with*. In its original sense, it's about connecting with the person being assessed in a way that helps gain a close understanding of what they know and understand. The purpose of assessment, then, is to gather evidence of learning—whether it is for the outdoor instructor, program, teacher, student, parent, district, state, or even nation. It's important that learning be recognized for the complex process it is. Currently, educators use many ways to assess what students know. Some of these methods look like traditional tests; others look very different. The kind of assessment you use depends on what information you want. We use the term *assessment* to refer to all those activities instructors use that gather information to be used as feedback to modify teaching and learning activities.

> **"When the cook tastes the soup, that's formative. When the guests taste the soup, that's summative."**
>
> *-Robert Stake, educational researcher*

Assessment is much more than tests! Many people think of assessment as simply tests students take before and after instruction. Those *are* assessments, but so is listening in on student discussions, watching students work, reading what students have written, asking students questions, and listening to their responses. Summative assessments are those given to students primarily when instruction is finished, to find out what students learned and maybe to assign a grade. Formative assessments take place *during* instruction and are used to figure out how to best adjust instruction to meet the needs of students. Embedded assessments are those that are part of learning experiences. Embedded assessments are often formative, but sometimes they can be summative. This session focuses on embedded formative assessments that field instructors can use to improve their instruction. The vocabulary and specific definitions of types of assessment can be confusing and are not the focus of this session. For the sake of not overwhelming instructors with vocabulary, the terms *formative* and *summative* are not part of the session; however, *embedded* (which we've found to be more intuitive to understand) is part of the session.

> **"Assessment specialists have found it useful to describe assessment as a process of reasoning from evidence—of using a representative performance or set of performances to make inferences about a wider set of skills or knowledge. The process of collecting evidence to support inferences about what students know and can do is fundamental to all assessments—from classroom quizzes, standardized achievement tests, or computerized tutoring programs, to the conversations students have with their teachers as they work through an experiment."**
>
> *-Developing assessments for the Next Generation Science Standards. National Research Council*

Teaching and learning must be interactive. One reason to emphasize and support assessment practices with your instructors is the tendency of many educators to overestimate what their students learn from their instruction. It can be a huge aha! moment when an instructor who has been teaching an activity or topic for a while, under the assumption that their students were really getting it, thoughtfully assesses student learning only to find out that many of those students are leaving with incomplete or inaccurate understandings about the topic. At the moment of this awareness, they may suddenly feel like less effective instructors, but this increased awareness from assessment is an important aspect of becoming more effective instructors. It helps instructors have a more realistic idea about

what their students are learning and gives them information they can use to improve instruction. One of the most important aspects of a quality educational program is an environment of reflective practice. That's when instructors aren't just leading a series of the same activities with each group, but are intentionally setting goals, trying out approaches and strategies to accomplish those goals, assessing to see how they went, and then making adjustments the next time they teach.

Field instructors need to know about their students' progress and struggles with learning so they can adapt their teaching to meet students' needs—needs that are often unpredictable and that vary greatly from one individual to another. Instructors can find out what they need to know in a variety of ways, including asking questions and listening when talking with students during *Walk & Talks* and *Turn & Talks*, observing students in the field, listening carefully during discussions, and reading students' written work. These are all considered embedded assessments because they are part of effective instruction. Such assessment becomes formative assessment when the evidence and information gained is actually used to adapt instruction to better meet students' needs. Opportunities for students to express their understanding should be designed into any and all pieces of teaching, because this enables instructors to receive and act on feedback directly from learners in order to improve and refine their teaching skills as well as enhance the curriculum. It kicks off an interactive connection between embedded assessment, teaching, and learning. Discussions, performance-based student activities, and journal prompts can all be used to give students those opportunities. Then it's vitally important for the instructor to look at or listen carefully to the talk, the writing, and the actions to get an idea of the state of student understanding.

Assessment is about gathering observations and making explanations from evidence. During quality teaching, the instructor is frequently gathering information about student understandings through listening in on discussions, asking questions, looking at student work, and so on. Making explanations from evidence is a key aspect of assessment because that's when an instructor attempts to make sense of their observations and tries to understand what students are thinking; that's the riskiest part of the process. It's risky because it's impossible to have certainty about anything that's going on in students' heads. It's also risky because it's easy to misinterpret and inaccurately explain your findings. Our unconscious biases may influence our explanations and cause us to jump to conclusions. We all have unconscious biases, and if we have unconscious biases about certain groups or individuals, we may unconsciously and unfairly judge their participation, work, and understandings, giving more benefit of the doubt to some while making negative assumptions about others. Without an awareness of these issues, an instructor can cause harm. Instructors need to intentionally work to avoid these biases and assumptions by spending time becoming more aware of their biases, by keeping all explanations *firmly grounded in evidence*, by maintaining uncertainty and open-mindedness about explanations, and by brainstorming multiple explanations rather than assuming that the first explanation that comes to mind is true. If this sounds familiar, it should, because it's very much like scientific thinking. Similarly with scientific thinking, as humans it's easy for us to slip into less scientific thinking and get carried away with our explanations, losing sight of the original observations. Instructors should hungrily gather observations during instruction and be careful, wary, and tentative when making explanations from their observations. Instructors can also maintain a focus on what the assessment says about their instruction, rather than only on what it says about students. Instruction is something instructors have control over, and keeping this perspective in mind helps improve instruction (and is far less risky).

> **"...assessment is always a process of reasoning from evidence. By its very nature, moreover, assessment is imprecise to some degree. Assessment results are only estimates of what a person knows and can do. Every assessment, regardless of its purpose, rests on three pillars: a model of how students represent knowledge and develop competence in the subject domain, tasks or situations that allow one to observe students' performance, and an interpretation method for drawing inferences from the performance evidence thus obtained."**
>
> *-Knowing What Students Know, National Academy of Sciences*

Emphasis on Formative Embedded Assessment

Best practices in teaching recommend that formative assessment should be woven into all stages of learning. We need to assess *before* new material is presented (to assess current knowledge), *during* the learning process (to see how well a student is grasping a concept), and *after* the lesson has been taught (to see how well the student understands the new material and to assess the effectiveness of the teaching). This lets an instructor evaluate and modify the learning experience in time to make a difference—rather than discover a problem just as it's time to move on to another subject.

Curriculum-embedded formative assessment practices create a continuous flow of information between instructor and student that guide the next steps in learning. It's important to actively involve students in the assessment process. Direct instructor feedback and expectations are shared with students to help them envision performance goals and understand what is needed for improvement. For example, when an instructor gives students feedback on how they are actively changing their minds about ideas and appropriately using language of uncertainty, the instructor is being explicit about expectations and about what students can do to improve and is also providing important feedback on how they're doing. When students clearly understand what's expected of them and receive specific feedback, then formative assessment information becomes an important guide for instructional improvement for both the instructor and the student. When an instructor allows students to be more in charge of their own learning, their motivation to learn is greatly increased. Research has shown that, when carried out effectively, formative classroom assessment that includes constructive feedback to students significantly raises the levels of student achievement. In this sense, quality formative assessment is indistinguishable from good teaching practices.

Informal assessments using narrow questions can be unproductive and can even inhibit learning. When students get to talk about their understandings in their own ways, it helps increase their knowledge and improves their understanding. Talking with a group of students also can give an instructor the chance to respond to and reorient their thinking. But there are many examples of discussions in which instructors have unconsciously responded in ways that inhibit student learning. Often this happens when the instructor is looking for a particular response and doesn't have the flexibility or confidence to deal with unexpected responses from students. Many instructors informally assess their groups by asking a series of narrow recall questions to check for understanding. Unfortunately, this natural and direct way of checking on learning is often unproductive. Another common problem is that, following a question, instructors don't wait long enough for students to think through their answers. When an instructor calls on the first raised hand or answers their own question after only two or three seconds (often because a minute of thoughtful silence seems intolerable), there isn't enough time for students to think deeply about the question. Sometimes, unintentionally, the instructor tries to direct the student with hints toward saying the answer they're looking for. In manipulating the dialogue toward a narrow goal, the instructor can sometimes block any unorthodox, though often thoughtful, attempts by students to work out their own answers. Over time, students get the message that they are not required to think out their own answers. The object of the exercise, they assume, is to work out—or guess—what answer the instructor expects to see or hear.

Assessment for learning is when students have:

- Understanding of instructional goals.
- Opportunity to develop skills and knowledge necessary to achieve goals.
- Ownership of their learning.
- Motivation to learn.

Instructors using formative assessment to support learning should:

- Develop clear learning goals for students.
- Provide opportunities to learn content in a deep way.

- Align assessment tasks with curriculum (what is taught) and instruction (how it is taught).
- Embed assessments at key points throughout instruction.
- Make changes to curriculum, instruction, and assessments based on assessment evidence from students.

Scoring guides and rubrics. These assessment tools are often used with assessments in formal classroom settings to help teachers evaluate different levels of student responses. They can be part of both formative and summative assessments and can be used to monitor progress in knowledge as well as abilities. Developing accurate and useful scoring guides and/or rubrics requires looking at many samples of student responses in order to capture a broad range of student understanding and to be able to represent the most common ways that learners build understanding of a particular concept.

Emphasis on Formative Embedded Assessment

Teachers in classrooms use summative assessments to measure student progress at the end of a unit or year of instruction. These kinds of assessments are more typically included in curriculum programs and textbooks and are designed to help find out what students have learned from the instructional materials. Since they take place *after* instruction, when students are preparing to move on to other topics, they have a very different purpose than formative embedded assessments. Summative assessments do provide feedback to the teacher about the success of the lessons, but this information can only guide instruction for the next time the materials are used, which is often not until the following school year. In this case, summative assessment can be referred to as assessment *of* learning, in direct contrast to formative assessments that are used throughout instruction as assessment *in support of* learning. In outdoor science programs, on the other hand, an instructor may often get a chance to apply the information to their instruction only a week or so later. Given the rapid cycle of instruction and repetition in many outdoor schools, the information from summative assessments may actually be used in a formative way.

Biases in assessment. We all have unconscious biases, and becoming more aware of these biases and then working to minimize them is important in assessment and instruction. Often, these biases can get "baked into" systems, such as assessments that are used regularly by programs but aren't regularly evaluated for their effectiveness. "Culture and background may lead to the inaccuracy of assessments, including traditional tests and alternative assessments. Standardized tests intend to measure intelligence and general knowledge, but they are normed based on the knowledge and values of the majority groups, which can create bias against minority groups, including gender, race, community status, and persons with different language backgrounds, socioeconomic status, and culture" (Kim & Zabelina, 2015). Teachers' different expectations for students of various racial or social classes are often correlated with less effective instructional practice (Leacock, 1969; Murray, 1996). Teachers often fail to identify potentially qualified students for selective programs in schools, especially when students are culturally different from them (Peterson, 2000).

To make any assessment more equitable, the prompt/task/question should be based on information and experiences that all your students have access to and should be both relevant and interesting to them. In outdoor science, assessments are ideally based on a common engaging experience in which the group has participated. Vocabulary can be a stumbling block to understanding how to respond, so it's important that the language be accessible to all students. Any difficult words should be used extensively and in context before appearing in assessments. Students who have more experience developing test-taking skills may be better at figuring out how to be successful on the assessment in ways that are not actually related to their understanding of the content. It's important to be clear about your expectations for responding, so all students know how to respond. Review your instruction and assessments (including questions you ask throughout your programs) for relevance and comprehensibility. Ideally, this should include guidance by a team that reflects the background of students you serve. Assessments represent one of many important reasons that people in leadership roles at your organization, including on the board, on the executive team, and as educators, should be representative of the communities of

students that you serve.

Stereotype threat. There is a large body of research on stereotype threat. Subtle and not-so-subtle perceptions of stereotypes have been shown to affect performance on assessments, even if the individual doesn't believe in the stereotype. If there is a negative societal stereotype about a particular group—for example, that black students underperform academically—the self-threat is thought to affect the intellectual performance of these students during assessments if they think the assessment measures intelligence. In this example, if students don't think the assessment measures intelligence, their performance is much better. "...[E]ven passing reminders that someone belongs to one group or another (e.g., asking the test taker to identify their race or gender on the test form), that has been stereotyped as inferior in academics, can wreak havoc with test performance.... By subtly altering the test situation to remove stereotype threat, Aronson and his colleagues have demonstrated dramatic improvement in standardized test scores among members of negatively stereotyped groups" (American Psychological Association, 2006). The book *Whistling Vivaldi and Other Clues to How Stereotypes Affect Us*, written by the social psychologist Claude Steele, is a very accessible read about stereotype threat and the underperformance of minority students in higher education.

There are things an instructor can do to reduce stereotype threat and bias:

- Reflect on unconscious biases they have and how their language might trigger certain responses from students, particularly during times when students feel they are being evaluated.
- Be transparent about how they are using information from journals and performance tasks: to help students formulate and express their ideas, to help themselves as instructors to understand what they got out of an experience, to help instructors improve their program and their teaching—and specifically *not* to evaluate the students.
- Have assessments reviewed by multiple stakeholders who represent the students served.
- Encourage students to have a growth mindset and to recognize that intelligence is not something you're just born with, but can be increased through effort.
- Encourage students to do self-affirmation, writing and/or talking about a value that is important to them, or a positive attribute they have. In 2006, researchers Geoffrey L. Cohen, Julio Garcia, Nancy Apfel, and Allison Master did a brief written self-affirmation with middle school students and found that it improved the grades of black students and reduced the racial achievement gap by 40%.
- Help students socially self-identify as part of the academic world. Help them see themselves as scholars/scientific thinkers.
- Communicate clearly that diversity is valued.
- Facilitate students' engaging with other students who are different from them.
- Reduce stress by helping all students feel seen and socially connected in the group.

Summative Assessment and Evaluation in Outdoor Science Programs

Many residential and multi-day outdoor science programs are interested in gathering summative information about student learning at the end of their programs. For this reason, student and teacher surveys are often used to get feedback about the effectiveness of field instruction and the success of specific program activities. These kinds of self-reporting surveys can indeed provide some information about important aspects of the program, particularly student attitudes, behavior, and social interactions. However, getting valid and reliable assessment information about what students have learned as a result of outdoor learning experiences conducted in an informal setting can be problematic. See the excerpts from the *Learning Science in Informal Environments* report highlighted below to read more about the complex conditions under which these kinds of assessment are developed and administered. This report provides both a broad description of science learning in informal environments and a detailed review of the

evidence of their impact on science learning. Published in 2009 by the National Research Council, it synthesizes literature across multiple disciplines to identify a common framework of educational goals and outcomes and provides insights into educational practices in informal settings such as outdoor science programs.

"The characteristics of informal learning environments make it very difficult to develop practical, evidence-centered ways to assess learning outcomes…[The assessment itself is] logistically complex, but also the data gathered are hard to interpret. It can be difficult to separate the effects of a single visit from other factors that could be contributing to positive learning outcomes. And arranging for tests before and after the experience or setting up other traditional measures…can be disruptive, or even inappropriate for the purpose that assessment may serve…[It] is important to consider the rationale for assessing learning in informal science learning settings.

[Informal learning] experiences cannot fully be prescribed or predetermined. Rather, the environments are learner-centered; so much of what happens emerges during the course of activities…The challenge thus becomes how to document the learning that occurs while not sacrificing the freedom and spontaneity that is integral to the experience.

The collaborative and social aspects inherent in many informal experiences also pose a challenge for assessing learning. Participants in summer camps, science centers, family activities, hobby groups, and such are generally encouraged to take full advantage of the social resources available in the setting to achieve their learning goals…Thus, assessments that focus on an individual's performance alone may "under-measure" learning…Assessing whether participants working in a group have grasped the science is important, but measuring the role that collaboration and problem solving have played in learning may be equally so.

…A first step in developing assessments is identifying the anticipated learning goals…It is equally important to understand what knowledge, skills, and beliefs the target audience brings to the learning situation… In fact, defining outcomes and target audiences for informal science learning experiences can be the most challenging tasks in the assessment process because it requires a deep understanding about purpose and the various ways in which informal experiences may be connected to past and future learning experiences… The development of assessments appropriate for science learning in informal environments should be guided by three criteria.

First, the assessments must address the range of capabilities that the designers have in mind, including not only cognitive outcomes, but also attitudinal, behavioral, and social outcomes…

Second, assessments should fit with the kind of participant experiences that make informal learning environments attractive and engaging. Any assessment activities undertaken in these settings should not undermine the very features that make for effective learning.

Third, the assessments must be valid; that is, they should measure what they purport to measure (construct validity) and align with opportunities for learning that are present in the environment (often referred to as ecological validity). In short, assessment measures should capture as much of the breadth of learning that a reasonable audience could experience, should align with the nature of the learning experience, and should represent in some faithful way the learning that actually occurs. Doing so is not easy."

-Surrounded by Science: Learning Science in Informal Environments , National Research Council

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