beetles

Science and Teaching for Field Instructors

Professional Learning Materials

Questioning Strategies

There are types of questions that incite student curiosity, exploration, discussion, and higher-level thinking. There are also types of questions that invite recall of information. Both types are valuable, but the first type tends to be underused. If you want students to explore, discuss and think, then your instructors should spend time learning the impacts of types of questions, and planning how to use them effectively. How instructors see their role as educators is also key to initiating exploration and discussion. Being an "entertainer" or "sage on the stage" has its places in outdoor science, but it's important to see the advantages of being a "guide on the side," who inspires students to explore the natural world and to encourage talk about science ideas.

This session focuses on two main types of questions—"broad" and "narrow" questions—also referred to in some education literature as "open-ended" and "closed-ended." The emphasis is on thinking about the impacts of both kinds of questions on student thinking and behavior, and using this information to help decide how and when to best use them. We also explore typical roles instructors can take when asking and answering questions, and how taking on these roles can either draw out student questions or, in the extreme, shut them down. At the end of the session, participants take part in an Activity Lab to plan to use some of the strategies they learned into their instruction.

While the sequence of the sessions largely depends on your goals, we recommend a three-session sequence of Making Observations, Questioning Strategies, and then Promoting Discussion. Making Observations focuses on three particular questions for exploration, and works great when used before this session. Questioning Strategies focuses on how to use questions to encourage student exploration and discussion. Promoting Discussion works well following Questioning Strategies, and focuses on the importance of discussion and on techniques and skills that promote meaning-making discussion.

Goals for this session are:

- **Experience and reflect on the different effects that narrow and broad questions have on student thinking and discussions;**
- **Note behaviors that reflect when an instructor sees their role as either "guide on the side", "entertainer", or "sage on the stage" and the impact this has on students;**
- **Apply questioning strategies to current teaching practice by seeking out opportunities to incorporate more broad questions;**
- **Practice matching goals for instruction with the appropriate questions.**

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 Los 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 Sancturary-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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Questioning Strategies

Contents

TEACHING ABOUT TEACHING

The presentations in this guide have been designed to "practice what we preach." This session reflects a learner-centered approach to instruction as participants experience a version of an effective instructional model while they learn about questioning strategies. It's important to maintain the structure of the session so participants experience questioning strategies for themselves, before discussing the implications for instructing students. Resist the temptation to provide a lot of information too early in the session. Simply telling instructors about questioning goes against the whole idea—participants will gain more from a meaning-making activity where they experience, discuss, and process this important pedagogical topic for themselves.

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 white boards, and/or print some out using black font on white background on as large sheets as possible. You may want to put them in plastic page protectors.

TIMING TIP

Keep things moving. The prompts provided in the session are purposefully designed to generate productive and interesting conversations, but 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

	Questioning Strategies	Activity Locations	Estimated Time
Invitation	**Introducing Questioning** This session starts off with partners discussing what instructors can do to encourage or discourage exploration.		10 minutes
Exploration	**Describe the Object** This brief exercise gets participants thinking about the different impacts of broad and narrow questions. The results tend to be pretty striking.	or	15 minutes
	Discussing Broad and Narrow Questions Participants are introduced to two types of questions: broad and narrow, and they explore how each type of question affects learners.		45 minutes
	Broad Questions in Action The leader models *Walk & Talk* as one way of incorporating more broad questions into instruction.		15 minutes
Concept Invention	**Acting Out Instructor Roles** Three brief skits are acted out, depicting the interactions between an instructor and students on a hike. Each skit represents a different role an instructor might take.	or	30 minutes
	Debriefing Instructor Roles Participants discuss how an educator's approach and assumptions about learning influence the way they interact with learners, and how learner's experiences are impacted.		15 minutes
Application	**Activity Lab** In pairs, partners apply what they've learned by choosing a scenario in your program that could use more broad questions.		45 minutes
Reflection	**Wrapping Up** Participants write in their journals responding to prompts about what they will take away from this session.		15 minutes
	TOTAL	**3 hrs, 10 min**	**~190 minutes**

PREPARATION

Before the day of the session:

1. **Prepare to present.** Choose who will present each part of the session (see below for info on model student activity). Consider including staff who have already experienced the session. Read through the session write up, slides, handouts, sidebars, and background section (page 47) to prepare to present. The more each presenter is able to "own" the session, the better the presentation. Write notes on a printed version of the session, or however you prefer. If you choose to present the entire session outdoors, make large copies of slides and/or print out half-page copies for yourself to refer to the information on them, or write on white boards. Modeling the student activity should be done outdoors, but if there's severe weather, you can either lead *Walk & Talk* while walking indoors, or do *Thought Swap* instead (a stationary version of *Walk & Talk*).
2. **Set up projection system/review multimedia.** Set up and test the projection system to be sure participants will be able to see.
3. **Gather 3 distinct objects/natural artifacts for the Describe the Object activity.** These can be any items you have handy, as long as they are large enough to be visible to the group and interesting to discuss and compare. Ideally, the group should not be too familiar with them—the more mysterious, the better. Some ideas: interesting skulls, especially marine organism skulls, a set of bones, a paper wasp nest, a large gall, bark beetle galleries. These items could also be somehow related to each other, such as a shell, a skull, and a bone, all representing hard body parts.
4. **Create list of narrow questions for Describe the Object activity.** Some suggested narrow questions are provided, but depending on the objects you gather, you'll probably need to brainstorm some of your own as well.
5. **Read and familiarize yourself with the *Walk & Talk* student activity guide; assess your ability to lead it.** Choose a staff member most experienced with successfully asking broad questions, leading discussions, and being a "guide on the side." The main body of that write-up is embedded in this *Questioning Strategies* write-up. If you'll be teaching the activity using the embedded write-up, we suggest you read through the separate BEETLES activity write-up for *Walk & Talk*, taking notes on the embedded write-up included here.
6. **Shorter Sessions.** If the session is too long for the time slots you have available, you can break it into two shorter sessions. The first session could be Introducing Questioning Through Broad Questions in Action. The second session could be Acting Out Instructor Roles Through Wrapping Up.
7. **Identify outdoor area.** This should be a nearby area and doesn't require anything special. You just need a place where the group can walk 2 abreast, and occasionally pause in the 2 lines for whole group sharing and discussion.
8. **Make sure participants are prepared.** Participants should bring the gear they need to be comfortable outdoors. Tell them to bring their journals, and something to write with.
9. **Make copies.** See list at right. Unless otherwise noted, print one handout per person.
10. **(*Optional*) Highlight copies of each script.** Make a copy of each script that has the lines and stage directions highlighted for each part (1 copy with just instructor lines highlighted, 1 with just Student 1 lines highlighted, etc.)
11. **(*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 & participants prefer having it, so they can see the trajectory of the session.

Immediately Before the Session:

1. **Set out the 3 objects in the meeting room for the Describe the Object**

MATERIALS

For the group:

- ❑ Projection system
- ❑ Computer
- ❑ Slides
- ❑ 3 distinct and interesting objects

Copies and Printed Materials:

- ❑ *"Broad Questions"* on page 28
- ❑ *"Narrow Questions"* on page 30
- ❑ *Scripts 1-3*, 1 copy for each participant + 5 more copies of each script (for the actors), on page 32-36
- ❑ *"Goals and Prompts for Encouraging Exploration" on page 37*
- ❑ *"Activity Lab: Instructions" on page 38* (one copy per pair)
- ❑ *"Questions And The Learning Cycle"* on page 39
- ❑ *"BFF Questions"* on page 40
- ❑ *"Types of Questions"* on page 41
- ❑ *"Research on Instructor Questions"* on page 42 (optional)
- ❑ *"Common Mistakes with Questioning"* on page 44

YOU ARE HERE:

10 minutes

TEACHING NOTES

Related sessions. See page 47 for more information on how this session connects to other BEETLES Professional Learning Sessions.

How can this session support a culturally relevant approach to science instruction in the outdoors? Good questions are at the heart of instruction that makes room for student voices, engages students in higher level thinking, and is responsive to individuals within a group of students. The session Questioning Strategies focuses on how to use questions to encourage student dialogue, higher level thinking, and exploration, and how to intentionally occupy a "role" as an instructor that best supports goals for students.

During the session, instructors:
think about when to use different types of questions, and how they might impact students' experiences
learn questions to encourage student exploration like, "What do you notice," which can be answered by any student regardless of their background knowledge or prior experiences
reflect on how broad questions create a more inclusive environment for science discussions, where divergent thinking is welcome and being "good at science" is not just about memorizing facts
reflect on how the different "roles" of an instructor might impact students' experiences
discuss the benefits of thoughtfully adopting a range of instructor roles to reach different goals for students

Introducing Questioning

1. **Show slide 1:** *Questioning Strategies*. **Introduce the session.**
   a. Welcome participants and check in with them.
   b. Make sure everyone's ready to begin.

slide 1

2. **Explain the session's focus is on questioning that leads to exploration and discussion:**
   a. A major goal of most outdoor science schools is to encourage students to engage with and explore nature.
   b. This session will focus on how we can ask questions that directly engage students with exploring nature, and also initiate some discussion.

3. **Ask participants to discuss guiding question: *How can an instructor use questions to encourage or discourage student exploration and discussion?***
   a. Tell partners to *Turn & Talk* about the guiding question.
   b. Wait a few minutes, then ask a few volunteers to share something they heard from their partner. (To encourage listening, it's important to ask them to share something they heard, not something they said.)
   c. Listen to their ideas.

4. **Explain importance of questioning strategies for discussion:**
   a. Teaching is a language-based profession and asking productive questions is a skill.
   b. Research shows that student discussion of ideas with peers, as well as with an educator is an important part of learning.
   c. Skillful questioning can inspire and facilitate productive educational discussions.

5. **Explain importance of questioning strategies for exploration in nature and thinking:**
   - The better an instructor is at asking questions, the more successful they can be at:
     - directly engaging students with the natural world
     - inciting students' curiosity and wonder
     - leading meaning-building explorations
     - inspiring higher-level thinking
     - making room for student voices
     - being responsive to individuals

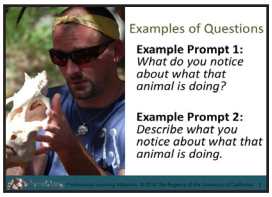
TEACHING NOTES

6. **Explain how skillful questioning can enhance field experiences:**
   - **a.** You could have a beautifully designed lesson, but without good questions and good questioning strategies, it won't be as productive as it could be.
   - **b.** Developing good questioning strategies and knowing when to use them can elevate field instructors to being true facilitators of wonder, curiosity, and inquiry outdoors.
   - **c.** The right question asked at the right time can make the difference between a successful field activity, and one that falls flat.

7. **Explain some instructor questioning skills:**
   - **a.** It takes practice to develop questioning skills.
   - **b.** Part of the skill is identifying which kinds of questions help you meet specific goals with your students.
   - **c.** One of the secrets to using questions effectively is to listen carefully to answers you get back!

8. **Explain that you'll be modeling thoughtful questions throughout the session:**
   - **a.** During the session, pay attention and think meta-cognitively about the questions used.
   - **b.** I'll be modeling the use of thoughtful questions throughout the session to help demonstrate how they can influence learning experiences, particularly explorations of found natural objects.

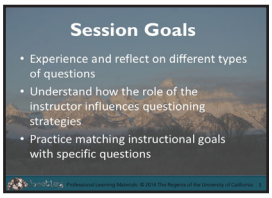
9. **Show slide 2:** *Examples of Questions*. **Explain that "questions" will include any statement that cues a response:**



slide 2

   - **a.** For our purposes in this session, we'll use a broader definition of questions than just statements with a question mark at the end.
   - **b.** A question is any prompt that elicits a response.
   - **c.** For example, I can ask, "What do you notice about what the animal is doing?" or I can say "Describe what you notice about what that animal is doing."
   - **d.** They both elicit the same response, and in this session, we'll refer to both as "questions."

10. **Show slide 3:** *Session Goals*. **Briefly review the goals for this session.**



slide 3

   - **a.** Read the goals aloud.
   - **b.** Explain: We'll address these goals throughout the session, starting by looking at different types of questions.

YOU ARE HERE:

15 minutes

TEACHING NOTES

Describe the Object

1. **Introduce the "describe the object" activity:**
   - **a.** Let's start with a simple activity that involves asking questions.
   - **b.** In pairs, discuss your answers to the questions.

2. **Hold up the first object and ask,**

   ▶ *What observations can you make about this object?*

   • Tell partners to talk for about one minute.

3. **Hold up the second object and ask partners to describe and compare it to the first.**
   - **a.** Set down the first object where it can be easily seen by the group, and hold up the second object.

     ▶ *What observations can you make about this object?*

     ▶ *How is this object the same or different from the other object?*
   - **b.** Tell partners to talk for about one minute.

4. **Hold up the third object and ask partners to describe and compare it to the first and second objects.**
   - **a.** Set the second object down, next to the first object, and hold up the third object.
   - **b.** Ask them to observe and describe this object,

     ▶ *What observations can you make about this object?*

     ▶ *How is this object the same or different from the other objects?*
   - **c.** Give partners about one minute to make these comparisons.

5. **Ask participants to identify each object. Point and ask:**

   ▶ *What is this object?*

   • Do this with each of the remaining objects in fairly quick succession.

6. **Ask *narrow* questions about each of the objects.**

   • Depending on your objects, ask questions with only one answer such as:

   ▶ *Which of these is from inside the body of an animal?*

   ▶ *What kind of animal is this object from?*

   ▶ *Which of these is from a gastropod?*

   ▶ *Which is from a mammal?*

   ▶ *Which of these is from a reptile?*

Calling out? Usually, when you ask the group to identify the objects instead of discuss observations, they automatically start calling out instead of talking to their partner. That's totally fine, and in fact, desired, as it demonstrates a common effect of narrow vs. broad questions.

Discussing Broad and Narrow Questions

YOU ARE HERE:

45 minutes

or

TEACHING NOTES

1. Ask how participants responded to initial questions

- **a.** Explain: These are the first questions I asked:
  - What observations can you make about this object?
  - How is this object the same or different from the other objects?
- **b.** Ask: How did you personally respond to these questions? How did the group respond to these questions?

2. Listen to responses.

- **a.** Allow wait time, listen to their ideas and ask follow-up questions
- **b.** Allow ~3 seconds wait time for participants to begin sharing their thoughts and observations.
- **c.** Their ideas may include the following:
  - encouraged observations
  - there was more than one acceptable response
  - opened up discussion
  - encouraged divergent thinking or different points of view

3. Ask how participants responded to the second set of questions

- **a.** Some of the secondary questions I asked were, "what is this," and (*add in the other questions you asked*).
- **b.** How did you personally respond to these questions?
- **c.** How did the group respond to these questions?

4. Listen to their responses.

- **a.** Allow a few participants to share their reflections.
- **b.** They may say:
  - recall of specific information
  - kept the exchange short and to the point
  - encouraged single, correct responses

You may want to capture these participant responses on chart paper or a white board.

5. Show slide 4: *Types of Questions*. Introduce broad and narrow questions.

- **a.** These questions can be put into two general categories—broad and narrow.
- **b.** The first set of questions I asked were broad, while the second set were narrow.

slide 4

Broad and narrow vs open-ended and closed-ended. There are other terms for these two categories of questions, and your participants may bring them up. You and your staff should use whichever terms work best for you. We prefer broad and narrow because the names are descriptive of the type of question, and narrow seems to have less of a negative connotation than some of the alternatives, like closed-ended.

6. Ask a few general questions about broad and narrow questions:

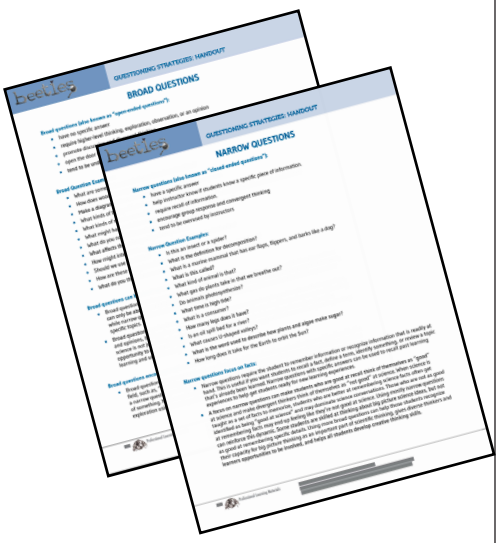
- **a.** Ask,

  ▶ *Did anyone feel more comfortable when I asked the broad questions?*

TEACHING NOTES

Different comfort levels? A large group will often be somewhat divided on whether they feel more comfortable with broad or narrow questions. This is interesting to point out, and is likely true for their students as well.

"Broad Questions" on page 28
"Narrow Questions" on page 30

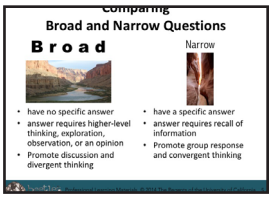


If the handouts seems too long... The section about broad questions on the handout may be too long for your participants to fully read during the given time. Let them know that they'll take the handout away with them and should read it more carefully later.

- *Did anyone feel more comfortable with the narrow questions?*
- *How did your observations of the objects change when I asked the broad vs. narrow questions?*

b. Listen to responses and ask a few follow-up questions to probe thinking.

7. Show slide 5: *Comparing Broad and Narrow Questions.* **Explain some of the differences between broad and narrow questions:**



slide 5

a. Broad questions can have any number of answers.

b. That's why they encourage students to explore, make observations, and voice their opinions and ideas.

c. It's also why they tend to lead to higher-level thinking.

d. Narrow questions have one specific answer, and ask for recall of information.

e. Neither type of question should be considered "good" or "bad."

f. They generate different types of responses and meet different types of goals.

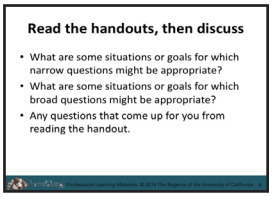
8. Explain that broad questions can be about specific topics:

a. Broad questions are sometimes confused with general questions.

b. Broad questions can be about specific topics, not just general topics.

c. What makes a question broad is that it has a broad range of ways students can answer it.

9. Show slide 6: *Read the handouts, then discuss...* **Explain the instructions:**



slide 6

a. You will each get a handout with more information about broad and narrow questions..

b. The handout will help you think about different goals broad and narrow questions can be used for.

c. Read the handout quietly.

d. Then, with your small group, discuss:

- What are some situations or goals for which narrow questions might be appropriate?
- What are some situations or goals for which broad questions might be appropriate?
- Any questions that come up for you from reading the handout.

10. Pass out "Broad Questions" and "Narrow Questions" handouts and tell them to begin.

a. Give one of each handout to each participant.

b. Give them 10-15 minutes for the assignment.

11. After participants have finished discussing, get the attention of the whole group and debrief. Ask:

- Let's hear what you talked about.

  - *What are situations or goals for which narrow questions might be appropriate?*
  - *What are situations or goals for which broad questions might be appropriate?*
  - *Was there anything you found interesting or confusing?*

12. Explain that the important thing is to keep goals in mind when deciding whether to ask a broad or narrow question:

a. When trying to figure whether to ask a broad or narrow question, keep your goal(s) in mind.

b. Only asking broad questions- or only narrow questions- is less effective than asking the "best" type of question to accomplish your goal.

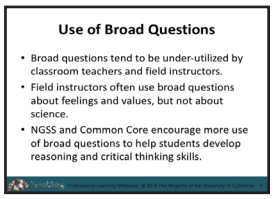
c. If your goal is for students to recall information, ask a narrow question.

d. If a goal of your field experience is for students to learn and figure things out through exploration and discussion, then:

- ask thoughtful questions
- ask mostly broad questions

e. If your goal is recall, but you ask a broad question, or if your goal is discussion but you ask a narrow question, it probably won't work very well.

13. Show slide 7: *Use of Broad Questions.* **Discuss why broad questions are used infrequently:**



slide 7

a. Explain: As we discussed, broad questions can help you with many meaningful goals, like higher level thinking, authentic discussion, exploration, and the inclusion of diverse and divergent viewpoints.

b. Explain: But research shows that in classrooms and other learning environments, broad questions are used much less than narrow questions.

c. Ask:

- *Why do you think educators use so few broad questions?*

d. Listen to and follow up on participant responses to guide a brief discussion.

TEACHING NOTES

Struggling with using broad questions with science content. At this point, depending on their experience with science instruction and questioning, some may be struggling with how broad questions can be used with science content. During the "Acting Out Instructor Roles" section of this session they'll have opportunities to see effective and ineffective uses of science content questions. The professional learning session, *Teaching & Learning* addresses when and how to deal with science content issues within an instructional sequence, and is often an "aha" experience for instructors. The professional learning session, *Constructing Understanding* is a more in-depth dive into how people learn, and can play an important role for instructors in shifting their ideas about education, but it's a more theory-focused session, and tends to be better later on in a professional learning sequence for instructors.

Learning: Recall vs deep thinking. Sometimes students (and instructors) get caught up in the idea that teaching is telling students facts, information, and names, and that learning is being able to repeat those back. Delivery of information, along with knowing facts and names, certainly has its place in learning, and narrow recall questions are certainly useful in that context. But deep and meaningful learning involves student thinking, and deep, quality teaching involves instructors facilitating student thinking, where students have to figure things out themselves. When talking about learning with staff, make sure it's clear what kind of learning you're talking about at the moment.

Research handout. There is an optional handout on questions research, "Research on Instructor Questions" on pages XX. It's meant to be handed out at the end of the session for those who are interested, but feel free to mention it here, or hand it out now if your group is particularly interested.

TEACHING NOTES

Hope for the future. Although historically broad questions have been underutilized by instructors, the Common Core State Standards and Next Generation Science Standards strongly advocate for more student-centered, inquiry-based, discussion and higher level thinking-focused instruction. They also lessen the previous emphasis on recall of facts. Hopefully, their influence represents significant positive shifts in instruction, including more use of broad questions.

When to correct student ideas. During discussion, students often share accurate ideas and information, along with inaccurate or incomplete ideas and information (much like many adult discussions). Sometimes it works fine to correct something in the moment, but it can also derail discussion and discourage students from sharing. Just telling the correct answer may feel efficient to an instructor, but does not guarantee that students will walk away with more accurate ideas. Because inaccurate ideas can be very persistent, learners often won't let go of them till they have had a chance to be confronted with evidence that contradicts them, with time to discuss and process. Instructors need to decide which inaccuracies are worth correcting, as well as how they can be corrected, which might include multiple additional activities.

About students discussing misconceptions. Research shows that scientifically accurate ideas tend to come out of discussion, even if all the individual students had misconceptions (Smith, 2009; Smith, 2011). This idea is addressed further in the BEETLES *Promoting Discussion* Professional Learning Session.

14. Bring up the following reasons, but only if participants don't:

- Worry that broad questions lead to open-ended discussions that may raise ideas that instructors do not understand or want to deal with.
- Instructor wants to maintain control of the conversation and thinks broad questions will allow students to wander off topic.
- Using mostly narrow questions to lead a briskly-paced exchange between students and the instructor, that stays on-topic, and avoids off-topic "distractions."
- Instructors may fall back on teaching the way they were taught (often mostly narrow questions) when they feel stressed.
- Narrow questions may seem simpler and safer for students, which can be true if they know the answer, but for students who don't know the answers, narrow questions can be intimidating.

15. Explain that many instructors are worried about students sharing inaccurate information, but there are strategies to deal with this:

a. A reason many instructors are hesitant to try using more broad questions is because they're worried that students will bring up misinformation.

b. It's useful to have ideas about what to do if that happens.

c. If students bring up misinformation an instructor needs to decide if it's important enough to deal with in the moment.

d. If it seems important to correct misinformation brought up by students, an instructor might:

- Add accurate information to the discussion, but usually not immediately, to avoid embarrassment and possible withdrawal of the student. Add it a little later without connecting it to the student's statement.
- Bring it up after the discussion, either with the group or with an individual.
- Give students evidence that contradicts the misinformation—ideally through direct experience, but, if that's not possible, then verbally or through another learning experience.

16. Explain that one way to deal with the challenge of learning questioning skills is to have some broad questions "in your back pocket" that are useful in many situations.

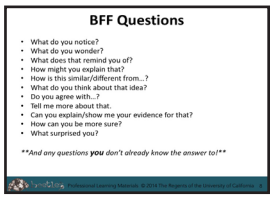
a. We know broad questions are underused, and that it can be challenging to learn to use them well.

b. Sometimes great questions come up spontaneously while you're teaching. Write those down afterwards, because they are instructional "gold!"

c. But really great questions can be hard to come up with, and often take planning.

d. One way to develop questioning skills is to have "pre-planned questions that can promote student thinking and exploration in many situations.

17. Show slide 8: *BFF Questions.* **Share BFF questions:**



slide 8

a. Here are some general broad questions to keep in your back pocket, literally.

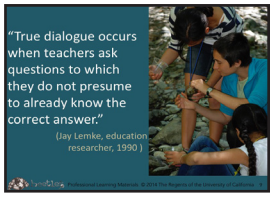
b. They are almost always useful, and can be Best Friends Forever (BFF) to encourage wonder, exploration, discussion, and reflection.

c. These are all on a handout that includes more than those shown here that you'll get at the end of the session.

d. You can use this sheet when you're planning student experiences, or as a reminder while teaching.

e. One often overlooked type of question is on this list twice—questions the instructor doesn't know the answer to!

18. Show slide 9: *"True dialogue occurs..."* **Encourage participants to seek out the edges of students' and their own understanding.**



slide 9

a. Take a moment to read the quote on the slide.

b. Students can feel it when an instructor is authentically wondering and trying to figure something out alongside them.

c. If your goal is engaging in authentic exploration, discovery, and exploration with students, don't avoid objects or subjects you know less about.

d. Instead, try actively seeking out "the edges of your own understanding," by modeling curiosity and inquiry when you come across something unfamiliar in nature or when a new idea is brought up.

19. Authentic questions can lead to genuine co-investigation and authentic inquiry.

a. These spontaneous explorations are a chance for you and your students to engage in an authentic investigation and try to figure something out together.

b. You can also try to take a fresh perspective when exploring aspects of nature you are very familiar with, finding new things to wonder about.

c. Even the most seasoned naturalist is surrounded in nature by things they have never noticed and mysteries they have not yet thought about.

d. We can be genuine collaborators and co-investigators with our students by admitting, "I don't know what this is or why it's here, let's check it out!"

e. It can be scary for students to admit they don't know something, and it's helpful if the instructor models being open and excited about not knowing something, and trying to figure it out.

YOU ARE HERE:

15 minutes

TEACHING NOTES

Broad Questions in Action

1. **A well-sequenced combination of broad and narrow questions can improve instruction.**
   - **a.** Well-sequenced questions that support your goals can inspire the sharing of ideas, and encourage students to come up with explanations.
   - **b.** They can help students recall prior knowledge, allow them to synthesize new information, and help guide logical thinking.
   - **c.** All these skills can support students in developing their understanding of their surroundings, or key concepts in science.

2. **Explain how to participate in *Walk & Talk*, and pay attention to questions asked:**
   - **a.** We'll take a look at one way to use broad questions in an activity called *Walk & Talk*.
   - **b.** As you participate, remember to think meta-cognitively about the questions and strategies I'm using.

3. **Explain that the next activity models a short sequence of broad questions used for content development and to pay attention to questions asked:**
   - **a.** We'll take a look at one brief example of how to use a sequence of broad questions in an activity called Walk & Talk.
   - **b.** As instructors, remember as you participate, to also pay attention to the questions and strategies I'm using.
   - **c.** The following sequence of questions are from the very beginning of a hike on ecosystems.
   - **d.** They are meant to access students' prior knowledge on the topic of ecosystems, and to get them interested and thinking about it.

4. **Model follow-up questions and wait time during Walk & Talk:**
   - **a.** As you lead the activity, model two important questioning strategy skills:
   - Follow-Up Questions: Ask questions that probe deeper both into an individual learner's response and the group's response. For example:
     - Can you explain your evidence for that?
     - Can you explain more what you mean by that?
     - Can anyone add on to what ____ is saying?
     - Would anyone care to respectfully disagree with that explanation?
   - Wait time: After each question, pause for at least 3 seconds of wait time before telling learners to start talking, either to one another or in the whole group setting.

5. Lead *Walk & Talk* activity with the following instructions.

6. Tell everyone to stand in two equal lines:

- **a.** Tell learners to form two parallel lines standing next to each other so each person has a partner in the line across from them.
- **b.** Include *yourself* in one line, so you'll also have a chance to talk to a few learners.
- **c.** Tell them to look across at the other line and identify their partner, with a greeting/icebreaker fist bump, high five, elbow bump, do-si-do, etc.
- **d.** If you have an odd number of learners, you can make one group of three learners.

7. Explain the directions:

- **a.** I'll ask a question to talk about with the partner across from you.
- **b.** The questions are in a sequence that might be used with students on an ecosystem-themed field experience.
- **c.** Each pair will discuss the question as we walk along the trail.
- **d.** After a few minutes, I'll start the "Touch of Silence" by gently touching the shoulder of the two people behind me.
- **e.** These two will then *gently* pass the touch down the line, until the entire group is quiet.
- **f.** We'll share out.
- **g.** Then we'll rotate.

8. Ask the first question, and begin walking:

▶ *Find out as many ways as you can in which you and your partner are connected. Music? Activities? Interests? People you know?*

9. Signal the Touch of Silence.

- **a.** Allow about 1–3 minutes for partners to discuss the first question.
- **b.** Wait for the entire group to become silent and to catch up with you, if they've gotten spread out on the trail.

10. Ask everyone to take a step back, & whole group share-out.

- **a.** Tell learners to take a step backward to make it easier for everyone to see each other.
- **b.** Call on 2-3 learners to share something their partner said about the question.

11. Shift lines to trade partners:

- **a.** Send your partner to the opposite end of their line and tell everyone in that line to shift one person down (towards you).
- **b.** Your line will not shift at all.

TEACHING NOTES

The student activity has been embedded in this professional learning session 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 differentiates the embedded student activity from the rest of the session.

How should staff behave during model activities? Some leaders ask participants to behave like children during model activities. We've found that this often leads to exaggerated negative behaviors, and the modeling suffers (sometimes the experience is ruined). Instead, ask them to participate as adults, while *imagining* how students would respond. There may also be times when they might get carried away with discussion of adult content to the point that it loses its effectiveness as a model, and as leader you may need to point this out and ask them to remember the level of their students, and tone down the content.

Sharing out in *Walk & Talk*. It's important to ask learners to share something their partner said. This encourages better listening and is especially valuable when first introducing discussion to a new group.

TEACHING NOTES

More about the rabbit, ecosystems, matter, and energy. It's easy for participants to get caught up in discussion about the rabbit, because it may highlight some of their own misconceptions about matter and energy. Let the conversation go for a few minutes to demonstrate how a broad question can spark curiosity, but not for so long that participants get distracted from thinking about questioning strategies. If you have staff members struggling with ideas about matter and energy (many do!), consider presenting the BEETLES content-based professional learning session, *Ecosystems, Matter & Energy* with them, which also features this same thought problem.

Is the Bunny Question a broad question or a narrow question? Not all questions are easily categorized! It's broad, in the sense that there are a variety of acceptable responses learners can share, such as, sweat, lost hair, bunny babies, etc. But the biggest idea behind the question also has a correct and incorrect response. In that sense it's narrow. The majority of the mass lost as organisms live and grow is through exhaling gases during respiration. It is a common misconception, even among science educators, that the matter turns into energy, which does not happen in life systems on Earth. If the instructor fixates only on this aspect, then it can be considered a narrow question. If the instructor listens respectfully, asks follow-up questions, without giving learners hints about the answers, the question works well to encourage divergent thinking and bring out student ideas. Then, it works as a broad question. Although it's important not to correct students during the discussion, it would be important to follow-up with a series of experiences that help students shift their understandings to be more accurate (see BEETLES *Ecosystems (and Matter) Theme Hike* and *Card Hike* (Energy/Matter version) student activity guide). See also the BEETLES professional learning session *Matter & Energy in Ecosystems* for more information.)

c. Make sure everyone looks across and identifies their new partner, with a greeting/icebreaker fist bump, high five, elbow bump, do-si-do, etc.

12. Repeat steps 4 through 7 with the following questions:

- *Who lives here? Look around. What organisms do you see? What organisms do you think live here that you are not seeing?*
- *Discuss as many ways as you can think of that organisms in this ecosystem might be connected with each other.*
- *This next one's challenging! Are you ready for it? In one year an 8 lb. rabbit may eat and drink ~ 400 lbs. of plants and water. About 140 lbs. comes out as poop and pee. But what happens to the other 260 lbs? Hmmm.*

13. Lead a short discussion about the *Walk & Talk* activity

a. Ask,

- *How might this sequence of questions work well to start off an ecosystems hike?*

14. Bring up the following if your group doesn't:

- The questions build on each other, starting with one that is a personal question.
- The series of questions helps students begin thinking about different connections that build toward understandings about ecosystems.
- The questions are also grounded in students personal experiences and ideas.

15. Explain that the last of those questions was an example of a challenging question for some groups that pushes students to think about and reveal their ideas about matter and energy:

a. The last question is pretty challenging for students and adults.

b. The Bunny Question is not meant for use with all groups - only if you think your group is ready to go there.

c. It tends to bring up misconceptions common among students (and instructors!).

d. It's meant to be used to kick off thinking and conversation about matter and energy, and should be followed up with more discussion after other experiences that challenge those misconceptions.

e. In a full field experience, there would be activities that support these questions, and many more questions mixed in for students to discuss.

16. Return inside and continue debriefing *Walk & Talk*:

- *What did you notice about Walk & Talk that set you up for success?*

a. Lead a brief discussion about what learners noticed about the *Walk & Talk* activity.

17. Explain that was an example of broad questions with a large group, but they also work well with small groups and individuals.

- **a.** This was one example of how to use broad questions with a large group.
- **b.** Broad questions are just as useful when working with smaller groups or individual students.

18. Explain follow-up questions you modeled:

- **a.** Another important type of broad question is follow-up questions.
- **b.** Follow-up questions are the ones I asked during the debriefs that either helped an individual formulate or explain their thoughts, or got the group to respond to an individual's thinking.
- **c.** Some examples of follow-up questions are:
  - Can you say more about what you mean by that?
  - What makes you think that?
  - Can you say more about that?
  - What's your evidence?
  - Does anyone disagree with that explanation?

19. Explain the value of wait time that you modeled:

- **a.** Wait time is a useful tool for instructors.
- **b.** 3 seconds of wait time has been shown to increase:
  - the length of student responses
  - the number of students who respond
  - the amount that students talk to one another
  - the amount of evidence that students use in their responses.

Acting Out Instructor Roles

1. Explain that next we will look at roles of instructors:

- **a.** We've looked at types of questions and how they affect instruction.
- **b.** The kinds of questions an instructor asks may also reflect how they see their role as an educator—and how they see their role may be revealed by the kinds of questions they ask.
- **c.** During the next activity we'll look at some different roles instructors often take on, and how each role influences instruction and the types of questions asked.

1. Explain that we will do 3 skits that model different instructor roles:

- **a.** We'll watch three separate skits modeling the interactions between a field instructor and their students.
- **b.** The skits are based on transcripts from observations of field instructors leading hikes.

TEACHING NOTES

Breaking up this session into two parts. If you have less time available than the 3+ hours needed for this session, we strongly recommend against only doing some of the session, but instead, break it up into two parts. The end of the "Broad Questions in Action" section of this session is a natural "intermission" point for exploring the topic broad and narrow questions, and the "Acting Out Instructor Roles" portion of this session could take place at another time. Between sessions you could ask instructors to try out using more broad questions, and be prepared to report back on how it went.

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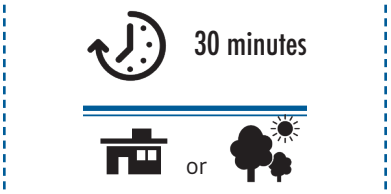
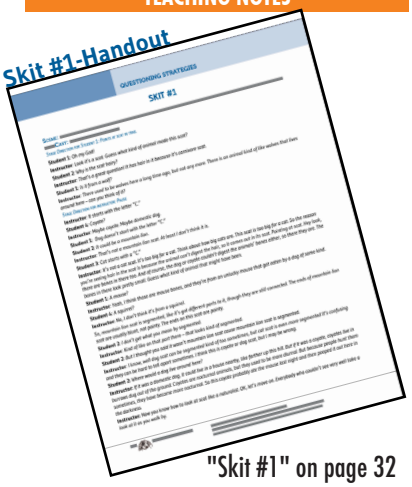


Make an extra copy of the skits yourself or use the ones at the back of this write-up, and read along, so you can help out if any participants lose their place as they're reading their lines.

TEACHING NOTES



"Skit #1" on page 32

Your staff will probably bring up most of the important points. Actively facilitate and listen to their ideas. Don't explain everything right now about the approach of the instructor in the skit, and don't bring up the "sage on the stage," yet. You'll have the chance later on to more formally introduce and describe this role.

Some things they may say. •did not encourage exploration or observation and missed an opportunity for collaboratively investigating an authentic question •did not effectively find out what the students were thinking by using probing questions, but instead had students guess what the instructor's guess was •gave an inappropriate response ("nope") when the student responded, that shut down the discussion •shared additional information (tracks) that took student attention away from exploring the scat.

"Skit #2" on page 33

c. Some parts are reproduced verbatim, while other parts are loosely based on observed dialogue.

2. Explain that each skit represents a different role, and that they should pay attention to role, as well as use of questions.

a. Each skit illustrates a different approach to the instructor's role, as well as the use of both broad and narrow questions.

b. While watching the skits, think about how the instructor views their own role, and pay attention to the use of, and kinds of questions.

3. Present the Role of the Instructor Skit #1.

a. Recruit 5 volunteers and assign them to their roles: Instructor and Student 1, 2, 3, and 4.

b. Hand out Skit #1 scripts to everyone so whole group can follow along.

c. Remind volunteers to read their parts loudly.

d. Tell them to begin.

4. Lead a discussion about what participants noticed in Skit #1.

a. Ask:

- *How would you describe the interaction between the instructor and the students in the first skit?*
- *What kinds of questions did the instructor ask? How did the instructor respond to student questions?*
- *How do you think the instructor saw their role as an educator?*
- *Was it student-centered? Instructor-centered? Nature-centered?*
- *Was there much science learning going on?*

b. Ask follow-up questions to guide the discussion and probe into participant thinking, such as:

- *What makes you think that?*
- *What's your evidence?*
- *What did the instructor/student say that led you to think that?*

5. Present the Role of the Instructor in Skit #2.

a. Either use the same volunteers or ask for five new volunteers and assign them to their roles: Instructor and Student 1, 2, 3, and 4.

b. Choose someone who has a sense of humor and who you think will be willing to "ham it up" to play the part of Student 3 in this skit.

c. Hand out Skit #2 scripts to everyone so whole group can follow along.

d. Remind volunteers to read their parts loudly.

e. Tell them to begin.

6. Lead a discussion about what participants noticed in Skit #2, using the same questions.

a. Ask:

- *How would you describe the interaction between the instructor and the students in the second skit?*
- *What kinds of questions did the instructor ask? How did the instructor respond to student questions?*
- *How do you think the instructor saw their role as an educator?*
- *Was it student-centered? Instructor-centered? Nature-centered?*
- *Was there much science learning going on?*

b. Ask follow-up questions to guide the discussion and probe into participant thinking, such as:

- *What makes you think that?*
- *What's your evidence?*
- *What did the instructor/student say that led you to think that?*

7. Present the Role of the Instructor in Skit #3.

a. Either use the same volunteers or ask for five new volunteers and assign them to their roles: Instructor and Student 1, 2, 3, and 4.

b. Choose someone who has charismatic leader skills who you think will be willing to "ham it up" to play the part of the Instructor in this skit.

c. Hand out Skit #3 scripts to everyone so the rest of the group can follow along.

d. Remind volunteers to read their parts loudly.

e. Tell them to begin.

8. Lead discussion on what they noticed in Skit #3, using the same questions.

a. Ask:

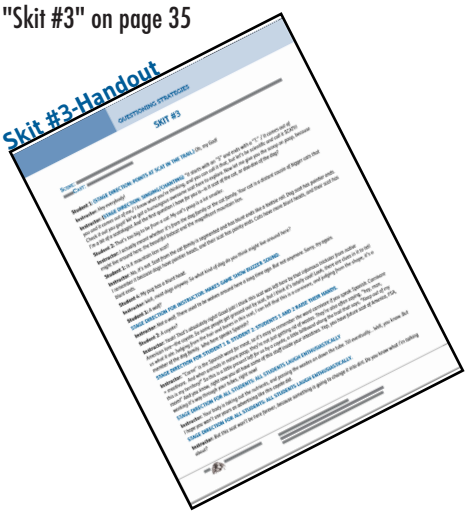
- *How would you describe the interaction between the instructor and the students in the third skit?*
- *What kinds of questions did the instructor ask? How did the instructor respond to student questions?*
- *How do you think the instructor saw their role as an educator?*
- *Was it student-centered? Instructor-centered? Nature-centered?*
- *Was there much science learning going on?*

b. Ask follow-up questions to guide the discussion and probe into participant thinking, such as:

TEACHING NOTES

Some things they may say: • Acted as a collaborator in investigating the answer by asking broad questions that created opportunities for high-level thinking, and follow-up questions that probed deeper into student thinking • Accepted all ideas from students without judging, made an effort to validate students' points of view; when possible, provided a guided opportunity for students to figure them out for themselves • Gently guided students to making scientific responses • Offered some content knowledge after the students had explored the scat, without squelching curiosity.

"Skit #3" on page 35



Some things they may say. • engaged students through performance • saw their job as dispensing knowledge to the students in a fun manner • never found out what the students' ideas were or provided the students with an opportunity to struggle with ideas or engage in higher level thinking • talked about exploration, but never provided tools or opportunities to explore • students thought the presenter was cool, but probably did not feel that nature is cool or that they could do science themselves.

TEACHING NOTES

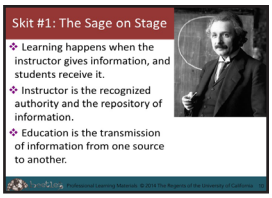
YOU ARE HERE:

15 minutes

Add new information, but avoid repeating points already mentioned. If you have already touched upon these points in your debrief of each skit, there is no need to repeat the information. Bring up any additional information that wasn't already mentioned or use the points here to add additional nuance to the understanding of each role.

- *What makes you think that?*
- *What's your evidence?*
- *What did the instructor/student say that led you to think that?*

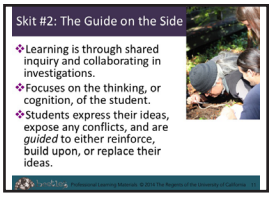
Debriefing Instructor Roles



slide 10

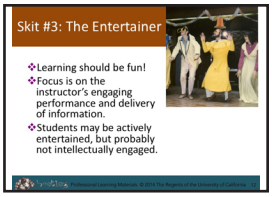
1. **Show slide 10:** *The Sage on Stage*. **Explain:**
   - An instructor's attitude about asking questions is often reflected in how they see their role as an educator.

2. **Explain the thinking behind being a "sage on the stage."**
   a. The "Sage on the Stage" role, as modeled in Skit #1, is shorthand for instructors who see themselves as transmitters of knowledge.
   b. For them, learning involves the instructor giving out information, and the student receiving it.
   c. The instructor is seen as the recognized authority.
   d. During "Sage on the Stage" instruction, there are usually few questions asked, and they're usually narrow.
   e. Instructor responses often serve to let students know if their answer was "right" or "wrong."



slide 11

3. **Show slide 11:** *The Guide on the Side.* **Introduce this instructor role.**
   a. In contrast, the "guide on the side" instructor role, modeled in Skit #2, is someone who sees them self as a facilitator of learning.
   b. This mode of teaching focuses on the thinking, or cognition, of the learner.
   c. The instructor facilitates learners building their own understanding through expressing and struggling with their ideas.
   d. The attitude toward learning is one of shared inquiry—being a co-collaborator with your students.
   e. A "Guide on the Side" often asks broad questions to help students make their own observations and explanations.
   f. Students are often talking and asking their own questions.

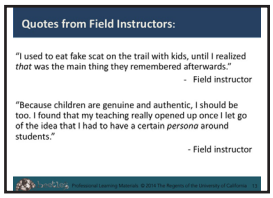


slide 12

4. **Show slide 12:** *The Entertainer*. **Introduce the "Entertainer" and explain:**
   a. These teachers are charismatic & entertaining, presenting information in a fun manner, using chants, songs, and/or clever phrasings.

b. They often present amusing monologues to students, asking narrow questions without engaging students in much meaning-making or higher-level thinking.

c. Passively receiving information—even while having a really good time—does not ensure students are making sense of what's presented.



slide 13

5. Show slides 13: *Quotes from field instructors.*

- Give participants time to read the slides.

6. Explain that being entertained can distract from observing and making sense of the natural world.

a. A focus on entertainment can lead to student intellectual passivity.

b. This can get in the way of students developing inquiry skills to explore and discover on their own.

c. It can be hard for students to think and process when they are caught up watching and responding to an entertaining educational "performance."

d. There may be nothing wrong with students bringing home memories of their instructor pretending to eat scat if that's what your goal is in the moment— but if the goal is student learning, the experience could distract students from that goal.

7. Ask participants for positive aspects to the entertainer role:

a. Explain: the problem is not with being entertaining per se, but with instructors consistently being the center of attention during exploration or meaning-making activities that could be more student- and nature-centered.

b. Ask:

▶ *There are many positive aspects of taking on an entertainer role in outdoor science school. What are a few you can think of?*

c. Listen to their ideas and add additional points from the sidebar if they are not mentioned.

8. Explain how "guide on the side" instructors often lack recognition and are pressured to take on an entertaining persona:

a. Instructors who take on the role of the entertainer often get a lot of positive reinforcement from teachers and students.

b. A less showy instructor, who acts more as a facilitator of learning, may feel pressure to be more outgoing or else remain under-appreciated.

c. But a skilled "guide on the side" who effectively engaging students in the topic, activity, and ideas, and empowering students to explore and think for themselves deserves very positive recognition.

TEACHING NOTES

Discussing the entertainer role. Because entertainers are often rewarded and encouraged in the outdoor science education culture, its might be worth discussing this role more extensively with your staff. This could be a heated discussion.

Some positive aspects to the entertainer:

- The instructor in Skit #3 had strong engagement skills and a positive encouraging attitude that can contribute to being an excellent activity leader.
- Chants, songs, rhymes, and clever ways of phrasing can be helpful for memorization.
  - There's nothing wrong with chants, songs, and games, and having fun while learning some vocabulary.
- Some entertainer episodes at outdoor science school can add to the fun, flavor, and enthusiasm of student experiences.

TEACHING NOTES

9. **Explain that some instructors combine "Guide on the Side" with "Entertainer" skills:**
   - **a.** There is no need to exclusively use one of these teaching styles- like broad and narrow questions, any of these roles can be useful in the right situation.
   - **b.** Some instructors effectively combine the skills of the entertainer with guide on the side.
   - **c.** Being fun and entertaining with students, coupled with an awareness of how to set up student-centered experiences and encouraging students to learn for themselves, can be an effective teaching style.

10. **Discuss appropriate uses of the roles:**

    ▶ *When might being an entertainer or a sage on the stage be appropriate in outdoor science schools?*

    - **a.** Accept a few responses, ask follow-up questions, and encourage dialogue, before summarizing.

11. **Summarize the discussion by emphasizing that knowing when to use different aspects of each role is a skill:**
    - **a.** Each role has positive aspects when used appropriately.
    - **b.** Knowing when and how to use different aspects of each role is a skill that can be intentionally worked on.
    - **c.** The idea is to be more conscious of the effects of these roles and to take them on according to your goals.

12. **Transition to the activity lab.**
    - **a.** The skits illustrate that asking good questions is not just a matter of knowing the definitions of narrow and broad questions.
    - **b.** It's also about knowing how to strategically use them for your goals.
    - **c.** Effective instructors choose the right type of questions, during appropriate moments, to reach particular goals they have in mind.
    - **d.** We'll get some practice with this in the next activity.

YOU ARE HERE:

45 minutes

Improving your curriculum library. We highly recommend collecting and incorporating participant's work in this section to add to your curriculum library.

Activity Lab

1. **Explain the goals of the Activity Lab:**
   - **a.** This activity is a chance to apply what we've been discussing to our current practice.
   - **b.** The goal is to look closely at one specific instructional situation in our program, and identify ways to incorporate more broad questions and appropriate narrow questions.
   - **c.** This is also an opportunity to improve our curriculum library.

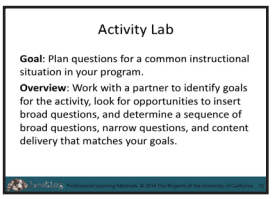
2. **Show slide 14:** *Exploration Goals*; **explain that the planning tool you'll get has 6 exploration goals and example questions for each goal:**

slide 14

   a. We'll use a planning tool to help provide some structure and consider what types of broad questions can support particular goals.
   b. Each section of this tool addresses a different goal you might have for leading an exploration.
   c. These goals are specifically centered around leading explorations of objects, organisms, and ecosystems.
   d. The goals all build on one another (it would be hard to do goal 6 without doing others).
   e. Instructors often need to have more than one goal in mind.
   f. A variety of prompts is also more engaging for students.

3. **Hand out** *Exploration Goals and Prompts* **sheet.**
   a. Reiterate that this a planning tool to help instructors—***not*** a script.
   b. Give participants a couple of minutes to read over the handout thoroughly.
   c. Ask if there are any questions.

4. **Show slide 15:** *Activity Lab*. **Explain that they'll choose a situation & look for opportunities to add broad questions:**



slide 15

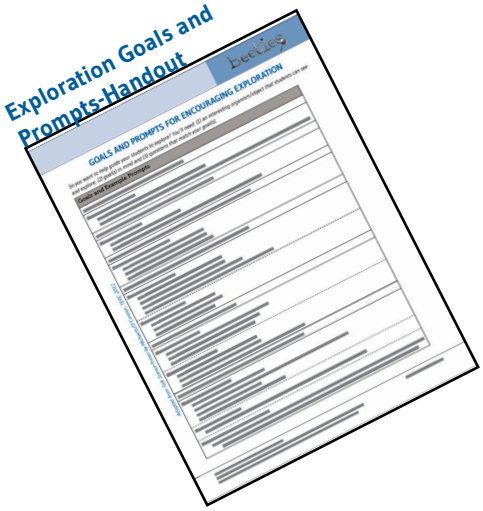
   a. In a group of four, you'll choose a common situation encountered in your program, such as a particular hike, or other field activity you think could use thoughtful question planning.
   b. You'll be looking for opportunities to incorporate more broad questions into your chosen situation.
   c. With a partner, you'll focus on planning and writing questions you can ask during this situation to help make it more effective.
   d. Then you'll return to your group of four to compare your plans.

5. **Pass out** *Activity Lab* **instructions:**
   a. Explain: This handout has detailed instructions.
   b. Give participants a few minutes to read over the instructions.
   c. Ask for any questions or clarifications.

6. **Hand out:** *Questions and the Learning Cycle*, **and** *BFF Questions*. **Explain:**
   a. Here are handouts that provide more scaffolding for this task.
   b. The first one includes the BFF questions we talked about earlier.

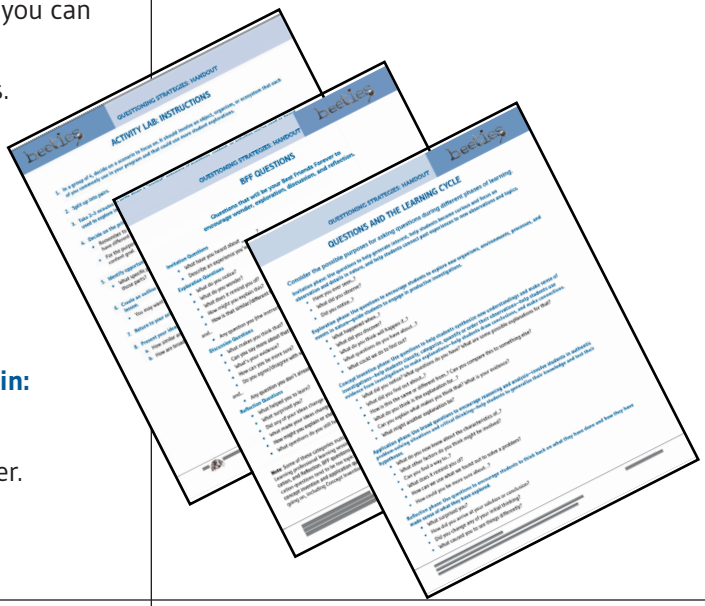
TEACHING NOTES

"Goals and Prompts for Encouraging Exploration" on page 37



Assigning or choosing scenarios? If you have specific lesson plans or activities you know need improvement, this might be a good opportunity to have your staff take a focused look at them. Otherwise, we recommend allowing participants to choose scenarios that most interest them. Make sure you decide this ahead of time so you can provide clear directions in the moment.

"Activity Lab: Instructions" on page 38
"BFF Questions" on page 40
"Questions And The Learning Cycle" on page 39



TEACHING NOTES

Haven't introduced the Learning Cycle yet? The learning cycle is the subject of the BEETLES *Teaching & Learning* professional learning session. It describes an instructional model for teaching in a way that supports how people learn. If you haven't done this session with your staff yet, you can choose to pass out the handout *"Questions and the Learning Cycle"* at the end of the session, or to use it during the activity. If you do, just be sure to explain that the learning cycle is a model of teaching that is supported by research.

c. The second connects back to the Learning Cycle and looks at questions one might ask to achieve the goals of each of the learning cycle phases (see sidebar if you haven't addressed the learning cycle).

7. Ask participants to form groups of four, split into pairs, and begin.

a. Form groups of four, then split them into pairs.

b. Allow a few minutes for pairs to talk on their own.

c. Spend some time listening and/or participating in the partner discussions.

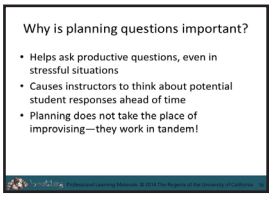
d. Help out groups that may be struggling, and may need guidance.

8. After ~ 30 minutes, tell everyone to return to their original group of 4 to present their ideas and give feedback to one another.

9. After ~ 10 minutes, bring the whole group back together.

10. Show slide 16: *Why is planning questions important?* **Discuss the importance of planning.**

▶ *Why plan questions? Why not just improvise questions?*



slide 16

a. Listen to their ideas and ask a few follow-up questions to probe thinking.

b. Bring up any of the following, but only if they weren't just brought up by the group:

- In a stressful teaching situation, instructors may ask whatever question pops into their head, defaulting to how they were taught- often with narrow questions.
- Planning questions gets you thinking about student responses, which helps you anticipate them and be better at connecting student ideas.
- A combination of planned and improvised questions can make instruction more meaningful.

YOU ARE HERE:

15 minutes

Wrapping Up

1. Discuss leading questioning plans with students.

▶ *What challenges and successes do you anticipate leading your questioning plans with students?*

- Listen to their ideas and ask follow-up questions of both individuals and the group.

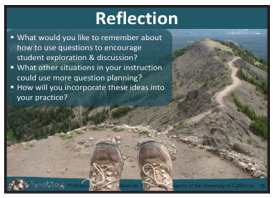
TEACHING NOTES

2. **Show slide 17:** *"An expert is..."* **Read the quote out loud and explain:**

slide 17

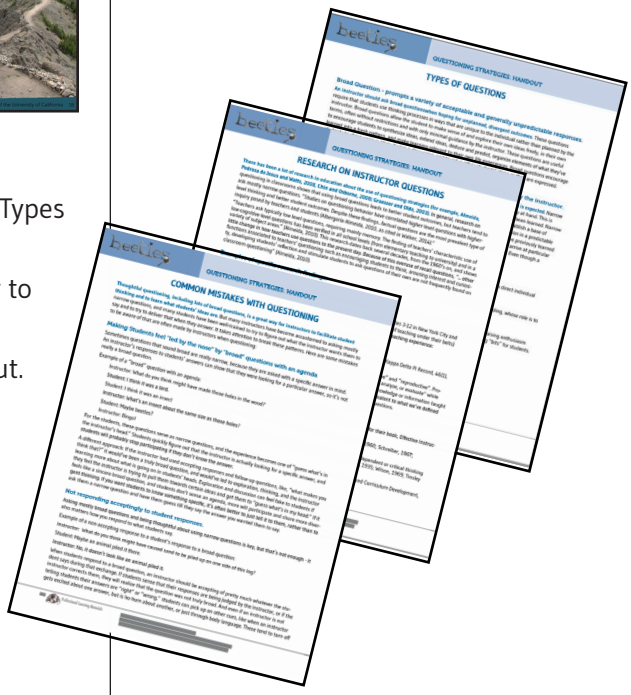
   a. The goal of this session was not for each of us to be experts on questioning strategies.
   b. It was to bring up some questions, share some research, and experiment with different strategies.
   c. Asking productive questions is challenging. Some of the questions you planned will be less productive, and others more productive.
   d. A key to shifting to a more broad questions-focused practice is being interested in what students are thinking.
   e. It takes practice and perseverance. If you're not immediately successful, keep trying.

3. **Show slide 18:** *Reflection.* **Give participants a few minutes to record reflections in their journals and pass out additional handouts.**



slide 18

   a. Offer the prompts shown on the slide to help participants reflect on the session and what they'll be taking away from it to apply in their teaching practice.
   b. Pass out the handouts: "Common Mistakes in Questioning" and "Types of Questions
   c. Tell them to keep the other handouts as a resource they can refer to and re-read later.
   d. Optional: Pass out the "Research on Instructor Questions" handout.



"Types of Questions" on page 41
"Research on Instructor Questions" on page 42
"Common Mistakes with Questioning" on page 44

TEACHING NOTES

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's some application included in the session, but—with all professional learning for instructors—the rubber meets the road (or trail) when instructors apply what they've learned to their instruction, and when they keep thinking and discussing with their peers. If you want your instructors to try out "new" activities/approaches, they'll need ongoing support from you. Even if they're excited by new ideas, it's easy for instructors, especially veteran instructors, to keep doing what they've been doing already, and not try out new activities/approaches. Some might react to content of this session as being simple, and that they "got it," but continue asking mostly narrow questions in their practice without realizing it. Some are able to transition to a more broad question-focused approach pretty naturally, but there are many who really struggle with it, and may continue asking mostly narrow questions, or ask a broad question, then give students hints or the "answer," or not really listen to student ideas. Below are a variety of follow-up activities and discussions to dig deeper into the topic, and help you facilitate thoughtful implementation.

- **Whole group staff brainstorm of what they and you can do to encourage incorporation of broad questions and the "Guide on the Side" role.** After the session reflection, your staff will already have written ideas about implementation into their instruction. You can tap into these and other ideas through a group brainstorm about what they plan to do and how you can support them in doing it.
- **Discussing Implementation of questioning strategies.** Assign your staff to each try out the plan they made with students during your next student program and write in their journals about how it went. Then lead them in a discussion during a meeting at the end of the program. Here's some suggested questions to focus a reflection or discussion on:
  - » Did your questions encourage exploration, thinking, discussion, and engagement with nature?
  - » What was successful about the activity?
  - » What might you do differently the next time you lead it and why?
  - » How did you incorporate questioning practice into students' other field experiences, and what ideas do you have about incorporating it in the future?
- **Instructor Observations.** If you do observations of instructors, discuss how you might incorporate elements from this session into what you look for during the observations.
- **Set aside time for your staff to read the handout, Common Mistakes in Questioning, and to discuss it.** This could work well after they have had a chance to work on their questioning during instruction with students.
- **Continuing a discussion from the session.** If there was a topic that came up during discussion that you had to cut off, set aside some time

to continue it.

- **Conduct a Questions Lab.** To give your instructors practice asking questions, set up a questions lab where they practice with each other. Bring in some interesting objects, and give one object to small groups of staff (5–6 people per group). Have each group spend a few minutes planning out a sequence of questions they might use with that object (using the *Goals and Prompts for Instructors* handout). Have each group nominate one person to be the leader, and have the leader rotate to a different group. You can keep repeating these steps to provide more staff members with a chance to be the leader. By the end, everyone should have participated in planning questions and many people should have had the opportunity to lead an exploration.
- **Take turns leading exploration outdoors.** Take group outside and instruct the group to find something of interest for everyone to explore. Once you've found something, choose a volunteer to lead the exploration, and choose some observers to fill out exploration checklists. Then do the same with a different leader and object.
- **Observe instructors, then discuss with group.** Arrange to observe as many field instructors as possible (even if it's just one). Arrange to discuss these with the team at next meeting.
- **Observe individual instructors.** Be sure to discuss their goals and specifics on what they would like you to observe beforehand. Some possible options related to this session are: use and number of broad and narrow questions; time spent with students making observations; evidence on any of the goals on the *Goals and Prompts* handout; or evidence of how an instructor views their role as an instructor. See BEETLES Coaching Materials for more information.
- **Gold Questions.** Create a binder, journal, or online document for your staff where they can collect "gold questions"—those questions that were truly productive and succeeded in getting kids to observe closely, think critically, or discuss with each other.
- **Before or after the session, assign your staff to read the "Intentional Curiosity" section from *The Laws Guide to Nature Journaling*.** Tell them to use Active Reading strategies: underline what they think are important points and write questions and connections they have in the margins. Then assign the prompts below to discuss, first in pairs, then in the whole group. Possible Questions/Prompts for Discussion:
  - » What are some points/quotes you found interesting? (You might ask each instructor to choose one quote from the passage, and be ready to explain what they think the author intended, questions/connections they have about it, and why they found it interesting.
  - » Which settings within our society encourage curiosity? Which settings discourage it? Why might that be the case?
  - » What are ways we can encourage a culture of curiosity within our program
  - » What information from this passage do you think might be worth communicating to students, and how might you do that?

TEACHING NOTES

Consider using the Tuning Protocol to help guide these discussions: www.nsrfharmony.org/system/files/protocols/tuning_0.pdf

See the full citation for The Laws Guide to Nature Journaling in the References section, on page 49.

BROAD QUESTIONS

Broad questions (also known as "open-ended questions"):

- have no specific answer
- require higher-level thinking, exploration, observation, or an opinion
- promote discussion and divergent thinking
- open the door for authentic discussion
- tend to be underused by instructors

Broad Question Examples:

- What are some differences between insects and spiders?
- How does wood decompose?
- Make a diagram of how decomposition happens in this ecosystem.
- What kinds of things affect where plants can grow?
- What kinds of structures and behaviors does this beetle have that might help it survive in its habitat?
- What might happen to these organisms if the environment changes?
- What do you notice about the water currents here?
- What affects the water quality where you live?
- How might inter-tidal organisms survive living in and out of water?
- Should we use pesticides?
- How are these young insects similar to and different from their adult stage?
- What do you think has caused the shapes of the landscape we're seeing?

Broad questions can be about specific topics and about science:

- Broad questions can focus on a specific topic. The name "broad" might make it seem like broad questions can only be about broad topics. But what makes them broad is that they have multiple acceptable answers, while narrow questions have only one acceptable answer. Broad questions can be about either general or specific topics.
- Broad questions can be about science content. Many instructors use broad questions about feelings, values, and opinions, but broad questions are also an important part of instruction about science content. Teaching science is not just delivery and recall of information. Asking students broad questions gives them the opportunity to engage in higher level thinking and productive struggle with science content, leading to deep learning and understanding.

Broad questions encourage exploration and curiosity:

- Broad questions encourage exploration and curiosity. Asking a broad question about something found in the field, such as, "What do you notice about this plant" tends to encourage deeper and longer exploration than a narrow question, such as, "what is this plant called?" Our curiosity tends to decline once we hear the name of something. Names and facts are useful, but it's better to share them after encouraging observation and exploration using broad questions.

Broad questions provide opportunities for thinking & learning:

- Broad questions give learners opportunities to think and learn. Broad questions prompt a variety of acceptable and generally unpredictable responses. To answer broad questions, students need to think in ways unique to the individual rather than planned by the instructor. Broad questions allow students to make sense of and explore their own ideas. When students respond to broad questions, it helps them clarify their thinking and form explanations. Broad questions encourage students to blend ideas, extend ideas, figure things out through reasoning, predict, and organize things they've learned into fresh patterns.
- Broad questions can initiate discussions that are important for learning. Learning is social. Students need to discuss and weigh new ideas to fully construct knowledge and understand science in a meaningful way. If students get the opportunity to share different viewpoints and participate in authentic discussion and an open exchange of ideas, their experience will be more memorable.
- Broad questions help students develop understanding of ideas and concepts, and to recognize their misunderstandings. While engaging in the higher level thinking needed to respond to a broad question, students may come to new understandings. By saying their thinking out loud, they may realize that they don't understand something.

Broad questions can promote cultural relevance:

- Broad questions help promote inclusive learning environments. Because broad questions have many acceptable answers, they encourage divergent thinking, multiple perspectives, and broad participation from group members. Using broad questions can help build a group culture where students value each others' ideas, and have space to share and relate learnings to their lived experiences.

Broad questions provide windows into student thinking:

- Broad questions give instructors opportunities to hear what students are thinking. Broad questions give instructors a chance to hear and understand how students are making sense of concepts, and what they might be struggling with. This window into student thinking gives instructors information they can use to customize instruction to where students are at.

NARROW QUESTIONS

Narrow questions (also known as "closed-ended questions"):

- have a specific answer
- help instructor know if students know a specific piece of information.
- require recall of information.
- encourage group response and convergent thinking
- tend to be overused by instructors

Narrow Question Examples:

- Is this an insect or a spider?
- What is the definition for decomposition?
- What is a marine mammal that has ear flaps, flippers, and barks like a dog?
- What is this called?
- What kind of animal is that?
- What gas do plants take in that we breathe out?
- Do animals photosynthesize?
- What time is high tide?
- What is a consumer?
- How many legs does it have?
- Is an oil spill bad for a river?
- What causes U-shaped valleys?
- What is the word used to describe how plants and algae make sugar?
- How long does it take for the Earth to orbit the Sun?

Narrow questions focus on facts:

- Narrow questions require the student to remember information or recognize information that is readily at hand. This is useful if you want students to recall a fact, define a term, identify something, or review a topic that's already been learned. Narrow questions with specific answers can be used to recall past learning experiences to help get students ready for new learning experiences.
- A focus on narrow questions can make students who are good at recall think of themselves as "good" at science and make divergent thinkers think of themselves as "not good" at science. When science is taught as a set of facts to memorize, students who are better at remembering science facts often get identified as being "good at science" and may dominate science conversations. Those who are not as good at remembering facts may end up feeling like they're not good at science. Using mostly narrow questions can reinforce this dynamic. Some students are skilled at thinking about big picture science ideas, but not as good at remembering specific details. Using more broad questions can help those students recognize their capacity for big picture thinking as an important part of scientific thinking, gives diverse thinkers and learners opportunities to be involved, and helps all students develop creative thinking skills.

Narrow questions can encourage synthesis of information:

- Narrow questions can help students synthesize information, as directed by the instructor. Specific questions that ask students to integrate what they've already learned can help students compare, contrast, associate, explain, state relationships, or arrive at certain conclusions. For example, "Look at the pictures of types of sea stars in the field guide and compare them with the sea star we saw. Which one was it?" or "What does the word, 'evidence' mean?" Even though a predictable answer is asked for, students may give an explanation in their own words.

Narrow questions prompt reliable responses:

- Narrow questions prompt a particular, predictable response planned by the instructor. When an instructor asks a narrow question, a specific "correct" response or set of responses is expected.

SKIT #1

Scene: A group is hiking with their instructor, with student #1 at the front, when they come across a large scat in the trail.

Cast: 1 instructor and 4 students

Note: Stage directions are in parenthesis and italics

Student 1: *(points at scat in the trail)* Oh my God!

Instructor: Look, it's a scat. Guess what kind of animal made this scat?

Student 2: Why is the scat hairy?

Instructor: That's a great question! It has hair in it because it's carnivore scat.

Student 1: Is it from a wolf?

Instructor: There used to be wolves here a long time ago, but not any more. There is an animal kind of like wolves that lives around here – can you think of it? *(Pausing for a few seconds)* It starts with the letter "C."

Student 4: Coyote?

Instructor: Maybe coyote. Maybe domestic dog.

Student 1: Dog doesn't start with the letter "C."

Student 2: It could be a mountain lion.

Instructor: That's not a mountain lion scat. At least I don't think it is.

Student 3: Cat starts with a "C."

Instructor: It's not a cat scat. It's too big for a cat. Think about how big cats are. This scat is too big for a cat. So the reason you're seeing hair in the scat is because the animal can't digest the hair, so it comes out in its scat. Pointing at scat. Hey look, there are bones in there too. And of course, the dog or coyote couldn't digest the animals' bones either, so there they are. The bones in there look pretty small. Guess what kind of animal that might have been.

Student 1: A mouse?

Instructor: Yeah, I think those are mouse bones, and they're from an unlucky mouse that got eaten by a dog of some kind.

Student 4: A squirrel?

Instructor: No, I don't think it's from a squirrel. So, mountain lion scat is segmented, like it's got different parts to it, though they are still connected. The ends of mountain lion scat are usually blunt, not pointy. The ends on this scat are pointy.

Student 2: I don't get what you mean by segmented.

Instructor: Kind of like on that part there – that looks kind of segmented.

Student 2: But I thought you said it wasn't mountain lion scat cause mountain lion scat is segmented.

Instructor: I know, well dog scat can be segmented kind of too sometimes, but cat scat is even more segmented It's confusing and they can be hard to tell apart sometimes. I think this is coyote or dog scat, but I may be wrong.

Student 2: Where would a dog live around here?

Instructor: If it was a domestic dog, it could live in a house nearby, like farther up this hill. But if it was a coyote, coyotes live in burrows dug out of the ground. Coyotes are nocturnal animals, but they used to be more diurnal. But because people hunt them sometimes, they have become more nocturnal. So this coyote probably ate the mouse last night and then pooped it out here in the darkness.

Instructor: Now you know how to look at scat like a naturalist. OK, let's move on. Everybody who couldn't see very well take a look at it as you walk by.

SKIT #2

Scene: A group is hiking with their instructor, with student #1 at the front, when they come across a large scat in the trail.
Cast: 1 instructor and 4 students
Note: Stage directions are in parenthesis and italics

Student 1: *(points at scat in the trail)* Oh, my God!

Instructor: Check it out! Look at the scat *[Student 1]* just found.

Student 2: It's humongous!

Instructor: What do you notice about it?

Student 2: Why is the scat hairy?

Instructor: What do you mean by it being hairy?

Student 2: I mean it looks like it has hairs in it.

Instructor: Those of you who are up close, can you tell us more about whether those look like hairs?

Student 1: They look like hairs to me.

Student 2: It's like made of hair.

Instructor: Can you describe the hairs for us? Color? Length?

Student 1: They look sort of gray.

Student 2: And twisted. It's almost like rope. Scat rope!

Student 1: It looks like a little bone in there too.

Student 2: Yeah!

Student 3: Yeah, it does look like gray hairs and it does look rope-y.

Student 4: I see the bones too.

Instructor: Anyone have an explanation for why there are hairs in the scat? What do you all think?

Student 3: It ate a hairy animal.

Student 2: It's a carnivore.

Student 4: Yeah, animals are meat.

Student 3: You are what you eat!

(Everyone laughs enthusiastically)

Student 1: So I guess this guy is hair and bones, cause that's what he ate.

Instructor: If it's a carnivore, how come there isn't meat in the scat? How come it's just hair and bones?

Student 1: It ate…I mean it digested the meat. But it can't digest the hair and bones, so they come out in its poop.

Student 3 : Oooooh. Bones in your poop! Ouch!

(Everyone laughs enthusiastically)

Student 2: Maybe his name was Harry Bones.

Student 3: Hey Harry! What happened to you? Feelin' kinda poopy today, Harry?

(Everyone laughs enthusiastically)

Instructor: Let's try to figure out more about old Harry Bones. Judging by the bones you can see, what size animal do you think he was?

Student 1: This looks like a little piece of a skull. It's only about an inch long.

Student 3: Maybe it's a mouse, or a rat.

Instructor: Can anyone think of any other animals that might live around here with a skull about that long?

Student 4: A squirrel?

Student 1: I think that a squirrel's head is bigger than that.

Student 4: No, it's not. Squirrels got teeny heads.

Instructor: Do you think the size of an animal's skull would affect whether it could be eaten by another animal or not?

Student 2: Yeah, cause if it has a big skull it couldn't fit it in its mouth.

Student 4: No, because it could eat around the head. It doesn't have to swallow the skull whole.

Instructor: OK, it sounds like based on the size of the skull in the scat we agree that the animal that was eaten was probably small animal with hair. What about the animal that ate it? About what size do you think it was?

Student 1: The size of a person?

Instructor: What makes you think that?

Student 1: It looks kind of like about the same size as a human scat.

Instructor: What animals around here might be that size?

Student 3: Maybe it's smaller than a person.

Student 1: Maybe it's a mountain lion.

Student 4: Or a wolf.

Student 2: There's no wolves around here.

Student 4: Maybe it's just a big dog.

Instructor: Sometimes you can get an idea about this from the shape of the scat. How would you describe its shape?

Student 1: It's like three sort of logs.

Instructor: Can anyone add to *[Student 1's]* description, and describe the shapes of those "logs" in more detail?

Student 2: They have pointy ends.

Instructor: Are all the ends pointy?

Student 2: No, that one isn't.

Instructor: Anyone else?

Student 2: It's like these little bumpy, lumpy logs.

Instructor: Do you all agree with that description?

All Students: Yeah.

Instructor: I read a book about scat, and it said that cat scats usually don't have pointy ends.

Student 3: Then this isn't mountain lion scat?

Student 4: Maybe it's from a coyote!

Student 2: But it does have one end that isn't pointy.

Instructor: Sometimes scat from members of the dog family has some ends that aren't pointy. It can be hard to tell for sure, and I'm not sure what this came from myself. But we did learn a bit about this scat through our observations. *[pause].* OK, what I want you all to do now is get a partner. And tell your partner what you think happened between old Harry Bones and whatever ate him or her. But we're being scientists here, so keep your explanation based on the evidence we have. Don't just make stuff up.

(Student 3 begins talking excitedly to student 1 while student 4 begins talking excitedly to student 2)

Student 3: I think it was a coyote. A big coyote. And it caught a mouse after waiting by its little hole till it came out. Then he like digested it, and then when he was running' along the trail, he was like, "I gotta go number two…"

Student 4: I think it was a coyote, because of the shape of the scat. I'm not sure what it ate, cause it seems like a mouse-size skull, but I don't know if coyotes would eat something as small as a mouse…

SKIT #3

Scene: A group is hiking with their instructor, with student #1 at the front, when they come across a large scat in the trail.
Cast: 1 instructor and 4 students
Note: Stage directions are in parenthesis and italics

Student 1: *(points at scat in the trail)* Oh, my God!

Instructor: Hey everybody!

Instructor: *(singing/chanting)* "It starts with an "S" and ends with a "T." / It comes out of you and it comes out of me./ I know what you're thinking, and you can call it that, but let's be scientific and call it SCAT!!! Check it out you guys! We've got a humongous awesome scat here to explore. Now let me give you the scoop on poop, because I'm a bit of a scatologist. And the first question I have for you is—is it scat of the cat, or doo-doo of the dog?

Student 2: That's too big to be from a cat. My cat's poop is a lot smaller.

Instructor: I actually meant whether it's from the dog family or the cat family. Your cat is a distant cousin of bigger cats that might live around here: the beautiful bobcat and the magnificent mountain lion.

Student 1: Is it mountain lion scat?

Instructor: No, it's not. Scat from the cat family is segmented and has blunt ends like a tootsie roll. Dog scat has pointier ends. I remember it because dogs have pointier heads, and their scat has pointy ends. Cats have more blunt heads, and their scat has blunt ends.

Student 4: My pug has a blunt head.

Instructor: Well, most dogs anyway. So what kind of dog do you think might live around here?

Student 1: A wolf?

Instructor: *(makes game show buzzer sound--bzzzzt)* Not a wolf. There used to be wolves around here a long time ago. But not anymore. Sorry, try again.

Student 2: A coyote?

Instructor: Yeah! That's absolutely right! Good job! I think this scat was left here by that infamous trickster from native American lore—the coyote. So some people get grossed out by scat, but I think it's totally cool! Look, there are clues in it to tell us what it ate. Judging from the hair and bones in this scat, I can tell that this is a carnivore, and judging from the shape, it's a member of the dog family.

Instructor: And when animals in nature poop, they're not just getting rid of wastes. They're also often saying, "hey, man, this is my territory!" So this is a little present left for us by a coyote, a little billboard along the trail that says, "Keep out of my room!" And you know, right now you all have some of this stuff inside your intestines. Yep, you have future scat of America, FSA, working it's way through your tubes, right now!

(Pause while all students laugh enthusiastically)

Instructor: Your body is taking out the nutrients, and passing the wastes on down the tube. Till eventually… Well, you know. But I hope you won't use yours as advertising like this coyote did.

(Pause while all students laugh enthusiastically)

Instructor: But this scat won't be here forever, because something is going to change it into dirt. Do you know what I'm talking about?

Student 2: The FBI!

Student 1: Fungus, bacteria, and insects!

Instructor: Fungus, Bacteria, and invertebrates! You almost had it, and insects are a type of invertebrate so it's real easy to get those words confused. Yep, the FBI are in there right now decomposing it into dirt and breakin' it down. Everybody say, "break it on down!"

All Students: Break it on down!

Instructor: Everybody say, "dookie into dirt!"

All Students: Dookie into dirt!

Instructor: Everybody say, "exploration!"

All Students: Exploration!

Instructor: Even exploring scat is cool and interesting, isn't it? Oh hey, look over here. *(Pretends to pick up a piece of scat from the ground, but it's actually a piece of an energy bar he has squished into a scat shape and secretly pulled from his pocket.)* I found another piece of scat over here. I wonder if this could be coyote scat. This one is harder to tell though. Let me see… *(pauses while sniffing the fake scat)*

All Students: Ewwwww!

Instructor: It sure smells like coyote scat. Hmmmm. But there is only one way to tell for sure. *(Instructor stares at it, then takes a bite.)*

ALL Students: *(very loudly and emphatically…)* EWWWWWWWW!

Instructor: Yep, that sure tastes like coyote scat.

Student 1: That's nasty!

Instructor: Anyone else hungry? Anyone want a bite?

(All students move away from the instructor)

Student 2: Gross!

Student 3: That's disgusting!

Student 4: I'm about to hurl!

Instructor: OK, now I'm gonna let you in on a little secret. That wasn't coyote scat I just bit into. It was an energy bar I made into a scat shape. I wasn't really eating scat. Touching and eating scat can actually be dangerous for humans. Some animals, like beavers, eat their own poop. But I was just faking it.

(Students laugh with relief)

Student 2: Man, you had me!

Instructor: Alright, let's go explore some more! Here we go!

GOALS AND PROMPTS FOR ENCOURAGING EXPLORATION

So you want to help guide your students to explore? You'll need: (1) an interesting organism/object that students can see and explore, (2) goal(s) in mind and (3) questions that match your goal(s).

Goals and Example Prompts

GOAL ONE: HELP STUDENTS MAKE BETTER OBSERVATIONS

❒ **1. Making Observations**
- → "What do you notice?" "What observations can you make?"
- → "What color is it? What shape? What texture? What size? How many are there? Where is it? What are surroundings like?"

GOAL TWO: HELP STUDENTS ASK QUESTIONS ABOUT OBSERVATIONS

❒ **2. Asking Questions**
- → "What does that make you wonder?"
- → "Can you think of questions we can ask that we can answer through observations?"

GOAL THREE: HELP STUDENTS CONNECT PAST IDEAS AND CURRENT EXPERIENCES

❒ **3. Recalling Prior Knowledge**
- → "How is this the same or different from…?"
- → "Can you compare this to something else?"
- → "Have you heard anything about this before?"

GOAL FOUR: HELP STUDENTS MAKE EXPLANATIONS BASED ON EVIDENCE

❒ **4. Making Explanations**
- → "What do you think is the explanation for…?"
- → "What do you think caused it to be like that?"
- → "What happened here?" or "What is happening here?"
- → "What type of animal do you think it was? What makes you think that?"

❒ **5. Including Evidence**
- → "What's your evidence for that?"
- → "Can you show us what you mean?"
- → "What makes you think that?"

GOAL FIVE: HELP STUDENTS THINK WITH OTHERS

❒ **6. Compare Thinking**
- → "How is this idea different from what Jamal said earlier?
- → "What do people think about what Ian just said?"
- → "Does anyone want to respond to that idea?"

❒ **7. Adding on to Thinking**
- → "How does that relate to what Jake said?"
- → "Can anyone add to what Keylee just said?"
- → "Can anyone put into words what they think Tanya is trying to say?"

GOAL SIX: HELP STUDENTS DEVELOP SCIENTIFIC ARGUMENTATION SKILLS

❒ **8. Disagree Productively**
- → "Do you agree/disagree? (and why?)"
- → "Does anyone have a different idea?" or "Does everyone agree with that explanation?"
- → "What do you think of that idea?"
- → "Can you rephrase that in a more polite way?"

❒ **9. Asking for evidence**
- → If someone says something and you don't know what their evidence is, be sure to ask for it.

❒ **10. Using Language of Uncertainty**
- → Remember that in science you've always got to keep your mind open so you shouldn't say or imply anything like "it's the absolute truth." Use "I wonder if," "Maybe," "The evidence seems to show," or similar phrases to express your ideas.

Adapted from Talk Science Primer by Michaels/O'Connor, TERC 2012

ACTIVITY LAB: INSTRUCTIONS

1. **In a group of 4, decide on a scenario to focus on.** It should involve an object, organism, or ecosystem that each of you commonly use or encounter in your program and that could involve more student explorations.

2. **Split up into pairs.**

3. **Take 2–3 minutes to write down a "normal" sequence of questions, content, or activities you've used or heard used to explore this scenario in the past.**

4. **Decide on the primary exploration goals and content goals.**
   - Remember to situate this scenario within the context of a group's entire time at your program—you may have different goals if this scenario takes place at the beginning or the end.
   - For the purpose of this activity, you need at least 1 exploration goal, but you don't necessarily need a content goal.

5. **Identify opportunities to include more broad questions into what you have been doing.**
   - What specific parts of the lesson could benefit from more broad questions? What are your specific goals for those parts?

6. **Create an outline of a sequence of broad questions and narrow questions/content delivery that improves this lesson.**
   - You may want to significantly restructure what you initially wrote down.

7. **Return to your original group of 4.**

8. **Present your ideas and new sequence. Discuss and provide feedback.**
   a. How similar and different are your new sequences?
   b. How are broad questions used to support exploration goals? How are they used to support content goals?

QUESTIONS AND THE LEARNING CYCLE

Consider the possible purposes for asking questions during different phases of learning.

Invitation phase: Use questions to help generate interest, help students become curious and focus on observation and details in nature, and help students connect past experiences to new observations and topics.

- Have you ever seen…?
- What did you observe?
- Did you notice…?

Exploration phase: Use questions to encourage students to explore new organisms, environments, processes, and events in nature—guide students to engage in productive investigations.

- What happened when…?
- What did you discover?
- What do you think will happen if…?
- What questions do you have about…?
- What could we do to find out?

Concept Invention phase: Use questions to help students synthesize new understandings and make sense of investigations—help students classify, categorize, quantify or order their observations—help students use evidence from investigations to make explanations—help students draw conclusions, and make connections.

- What did you notice? What questions do you have? What are some possible explanations for that?
- What did you find out about…?
- How is this the same or different from..? Can you compare this to something else?
- What do you think is the explanation for…?
- Can you explain what makes you think that? What is your evidence?
- What might another explanation be?

Application phase: Use broad questions to encourage reasoning and analysis—involve students in authentic problem-solving situations and critical thinking—help students to generalize their knowledge and test their hypotheses.

- What do you now know about the characteristics of…?
- What other factors do you think might be involved?
- Can you find a way to…?
- What does it remind you of?
- How can we use what we found out to solve a problem?
- How could you be more sure about…?

Reflection phase: Use questions to encourage students to think back on what they have done and how they have made sense of what they have explored.

- What surprised you?
- How did you arrive at your solution or conclusion?
- Did you change any of your initial thinking?
- What caused you to see things differently?
- How did you figure out…?

BFF QUESTIONS

Questions that will be your Best Friends Forever to encourage wonder, exploration, discussion, and reflection.

Invitation Questions

- What have you heard about _____?
- Describe an experience you've had with _____?

Exploration Questions

- What do you notice?
- What do you wonder?
- What does it remind you of?
- How might you explain this?
- How is that similar/different than _____?

and...

- Any question you (the instructor) don't already know the answer to!

Discussion Questions

- What makes you think that?
- Can you say more about that?
- What's your evidence?
- How can you be more sure?
- Do you agree/disagree with what _____ just said?

and...

- Any question you don't already know the answer to!

Reflection Questions

- What helped you to learn?
- What surprised you?
- Did any of your ideas change during this activity?
- What made your ideas change?
- How might you explain or show some of what you learned in this activity to a family member?
- What questions do you still have about _____?

Note: Some of these categories match up nicely with phases of the Learning Cycle (addressed in the BEETLES Teaching & Learning professional learning session). The Learning Cycle phases are: Invitation, Exploration, Concept Invention, Application, and Reflection. BFF questions are questions that can be used in many contexts, but Concept Invention and Application questions tend to be too topic-specific for a list such as this. See Broad Questions handout for examples of specific concept invention and application questions Discussion questions can be used in any phase when there's discussion going on, including Concept Invention.

TYPES OF QUESTIONS

Broad Question - prompts a variety of acceptable and generally unpredictable responses.

An instructor should ask broad questions when hoping for unplanned, divergent outcomes. These questions require that students use thinking processes in ways that are unique to the individual rather than planned by the instructor. Broad questions allow the student to make sense of and explore their own ideas freely, in their own terms, often without restrictions and with only minimal guidance by the instructor. These questions are useful to encourage students to synthesize ideas, extend ideas, deduce and predict, organize elements of what they've learned into a fresh pattern, and make learning relevant to their own life experiences. Broad questions encourage students to share various ideas during a discussion, and to value other students' ideas as they are expressed.

Narrow Question - prompts a particular, predictable response planned by the instructor.

When an instructor asks a narrow question, a specific "correct" response or set of responses is expected. Narrow questions require the student to remember information or recognize information that is readily at hand. This is useful to help students recall a fact, define a term, identify something, or review a topic that's been learned. Narrow questions with specific answers can be used to recall previous learning experiences to help establish a base of information for new experiences. Narrow questions can also help students synthesize information in a predictable way, as directed by the instructor. Specific questions that ask students to integrate what they've previously learned are useful if you want students to compare, contrast, associate, explain, state relationships, or arrive at particular conclusions. "Compare," "tell," and "explain" can begin these kinds of integrating statements. Even though a predictable answer is asked for, students may give an explanation in their own words.

Roles for Instructors:

Guide on the Side. Educators who see themselves as facilitators of student learning, helping to direct individual student discoveries and acting as collaborators while investigating topics together.

Sage on Stage. Educators who see themselves as expert bearers of information and understanding, whose role is to fill students' heads with the correct information and facts.

Entertainer. Educators who see themselves as making learning fun, primarily responsible for raising enthusiasm and encouraging excitement about science, by providing an engaging persona and entertaining "bits" for students.

RESEARCH ON INSTRUCTOR QUESTIONS

There has been a lot of research in education about the use of questioning strategies (for example, Almeida, Pedrosa de Jesus and Watts, 2008, Chin and Osborne, 2008; Graesser and Olde, 2003). In general, research on questioning in classrooms shows that using broad questions leads to better student outcomes, but teachers tend to ask mostly narrow questions. "Studies on questioning behavior have correlated higher-level questions with higher-level thinking and better student outcomes. Despite these findings...factual questions are the most prevalent type of inquiry posed by teachers and students (Albergaria-Almeida, 2010, as cited in Walker, 2014)."

"Teachers ask typically low level questions, requiring mainly memory. The finding of teachers' characteristic use of low-cognitive-level questions has been verified in all school levels (from elementary teaching to university) and in a variety of subject areas." (Almeida, 2010). This research dates back several decades, from the 1960's on, and shows little change in how teachers use questions to the present day. Because of this overuse of recall questions, "... other functions associated to teachers' questioning such as encouraging students to think, arousing interest and curiosity, developing students' reflection and stimulate students to ask questions of their own are not frequently found on classroom questioning" (Almeida, 2010).

Examples of specific research findings:

Experienced teachers use more broad questions than novice teachers:

From 2001-2007, Teinken, Goldberg, and DiRocco (2009) studied 98 teachers of grades 3-12 in New York City and New Jersey. They found that more experienced teachers (those with 4 or more years of teaching under their belts) asked over twice as many broad* questions as teachers with less than four years of teaching experience:

- 15% - Average percentage of broad questions* asked by new teachers
- 32% - Average percentage of broad questions asked by experienced teachers

Citation: Tienken, C. H., Goldberg, S., & Dirocco, D. (2009). Questioning the questions. Kappa Delta Pi Record, 46(1), 39-43.

*In their study, Teinken, Goldberg, and DiRocco categorized questions into "productive" and "reproductive". Productive questions were those that provided students with the opportunity to "create, analyze, or evaluate" while reproductive questions were those that asked students to "imitate, recall, or apply knowledge or information taught by the teacher." We suggest that what they describe as productive questions are equivalent to what we've defined as broad questions, and reproductive questions serve the same purpose as narrow questions.

Classroom teachers in general tend to ask more narrow questions:

In 1981, Levin and Long reviewed research on questioning from 1900 through 1980 for their book, Effective Instruction. They documented the following findings:

- Classroom teachers ask between 300-400 questions a day (Gall, 1970; Floyd 1960; Schreiber, 1967; Stevens, 1912).
- On average, only 20% of questions asked by teachers stimulated students' independent or critical thinking (Arnold and others, 1973; Corey, 1940; Floyd, 1960; Gallagher, 1965; Haynes, 1935; Wilson, 1969; Tinsley and others, 1970).

Citation: Levin, T., & Long, R. (1981). Effective Instruction. Association for Supervision and Curriculum Development, 225 North Washington Street, Alexandria, VA 22314

Asking a Series of Narrow Questions "takes over" Learner Thinking:

A video study of 129 teachers engaged in one-on-one conversations about 1798 math problems found that asking a series of narrow questions was a common teaching move used to take over children's thinking. Through these questions, the problem is broken down into tiny steps that are easy and obvious, and that require minimal effort and little understanding on the part of the student. These have the effect of getting students to an answer without engaging them in reasoning for themselves, and without them understanding what happened. See Asking a quick barrage of leading narrow questions on the handout, Common Mistakes with Questioning.

Citation: Jacobs, Martin, Ambrose, & Philipp. (2014). Warning signs! Teaching Children Mathematics, 21, (2), [107-113]

In addition to this research, BEETLES found, in field observations, that:

- Field instructors tend to overuse narrow questions and underuse broad questions.
- In observations of outdoor science instruction in 2012, similar questioning trends were observed by BEETLES staff. BEETLES staff visited 6 Northern California residential outdoor science programs and observed 8 all day hikes led by instructors that their program leaders identified as representative of their program. BEETLES staff observed that:
  - Very few broad questions were asked.
  - Many narrow questions were asked.
  - The broad questions that were asked were often about feelings or values, not about science ideas.
- In 2014, observations of three Northern California outdoor science schools using BEETLES approaches revealed that ~80% of the questions asked by field instructors were broad, and ~20% were narrow.

COMMON MISTAKES WITH QUESTIONING

Thoughtful questioning, including lots of broad questions, is a great way for instructors to facilitate student thinking and to learn what students' ideas are. But many instructors have become accustomed to asking mostly narrow questions, and many students have been well-trained to try to figure out what the instructor wants them to say and to try to deliver that when they answer. It takes attention to break these patterns. Here are some mistakes to be aware of that are often made by instructors when questioning:

Making Students feel "led by the nose" by "broad" questions with an agenda

Sometimes questions that sound broad are really narrow, because they are asked with a specific answer in mind. An instructor's responses to students' answers can show that they were looking for a particular answer, so it's not really a broad question.

Example of a "broad" question with an agenda:

Instructor: What do you think might have made those holes in the wood?

Student: I think it was a bird.

Student: I think it was an insect

Instructor: What's an insect about the same size as those holes?

Student: Maybe beetles?

Instructor: Bingo!

For the students, these questions serve as narrow questions, and the experience becomes one of "guess what's in the instructor's head." Students quickly figure out that the instructor is actually looking for a specific answer, and students will probably stop participating if they don't know the answer.

A different approach: If the instructor had used accepting responses and follow-up questions, like, "what makes you think that?" it would've been a truly broad question, and would've led to exploration, thinking, and the instructor learning more about what is going on in students' heads. Exploration and discussion can feel fake to students if they feel the instructor is trying to pull them towards certain ideas and get them to "guess what's in my head." If it feels like a sincere broad question, and students don't sense an agenda, more will participate and share more divergent thinking. If you want students to know something specific, it's often better to just tell it to them, rather than to ask them a narrow question and have them guess till they say the answer you wanted them to say.

Not responding acceptingly to student responses.

Asking mostly broad questions and being thoughtful about using narrow questions is key, but that's not enough - it also matters how you respond to what students say.

Example of a non-accepting response to a student's response to a broad question:

Instructor: What do you think might have caused sand to be piled up on one side of this log?

Student: Maybe an animal piled it there.

Instructor: No, it doesn't look like an animal piled it.

When students respond to a broad question, an instructor should be accepting of pretty much whatever the student says during that exchange. If students sense that their responses are being judged by the instructor, or if the instructor corrects them, they will realize that the question was not truly broad. And even if an instructor is not telling students their answers are "right" or "wrong," students can pick up on other cues, like when an instructor gets excited about one answer, but is ho-hum about another, or just through body language. These tend to turn off

student thinking and discussion.

A different approach: Student answers to broad questions should get neutral-ish responses form the instructor, that show interest, but a lack of judgment. For example saying, "Hmm, that's interesting. What do others think of that idea?" The instructor can ask follow up questions, such as, "What makes you think that?" These should be asked in a fairly neutral voice, so students aren't just trying to get a positive reaction from the instructor, but are focused on figuring out the challenge they've been given.

Asking a quick barrage of leading narrow questions

Students can also feel led by the nose when instructors misuse narrow questions by asking a bunch of them in a quick sequence.

Example of a narrow question barrage:

Instructor: Are the leaves green?

Student: Yes.

Instructor: Do green leaves photosynthesize?

Student: Yes.

Instructor: So, does this plant photosynthesize?

Student: Yes.

Although the instructor may think this was a productive discussion, and that the student understands the concept, because they answered every question "right," the student had no chance to share their ideas. The instructor started off with an easy narrow question, then kept following it up with a series of more narrow questions. This has the effect of breaking the idea down into tiny simple steps, each of which takes very little effort and understanding. The student may just be guessing what answers they think the instructor wants them to say, and saying them. Their answers don't necessarily mean they understand a concept, and the instructor learns very little about what the student knows.

A different approach: The instructor could've asked a broad question, such as, "what have you heard about leaves and photosynthesis?," along with follow-up questions to bring out student ideas on the topic. Broad questions lead to deeper responses that show students' thinking. If misconceptions came up, the instructor could deal with those with evidence and reasoning. If there is specific content that the students need, the instructor can tell that to them.

Asking a narrow question to start discussion.

If the instructor's goal is for students to share a specific response, they should ask a narrow question. But sometimes instructors ask narrow questions when they're hoping to start a discussion, which usually doesn't work.

Example of a narrow question used to try to start a discussion:

Instructor: What is the biggest animal in the ocean?

Student: Giant squid?

Instructor: There's an animal bigger than that.

Student: A whale shark?

Instructor: A whale shark is big, but this is bigger. Think mammals.

Student: A whale?

Instructor: What kind of a whale?

Student: A blue whale?

Instructor: Yep, and blue whales are the biggest animal to ever live on Earth.

One way to tell that the question is narrow and it's not a real discussion is when the instructor starts giving students hints at the answer they're hoping for.

A different approach: To start discussion or exploration, use broad questions and accepting responses. Broad questions (for example, "what do you think is the most successful organism on Earth?") have multiple possible answers, and that makes them interesting to think about and discuss.

BACKGROUND INFORMATION FOR PRESENTERS

Questioning is a vital and powerful teaching strategy, and a crucial component of just about any teaching situation. This is especially the case when learning situations derive from student experience, where questions and reflections about that experience are used to develop and refine concepts. Questions can open doors at every stage of the learning experience—inviting students into activities and ideas by creating interest in a new topic, helping guide students' active explorations, stimulating reasoning and sense-making of new concepts, and encouraging students to apply their ideas to different situations. Well-sequenced questions can initiate the sharing of ideas, encourage development of multiple hypotheses or alternative explanations, help students recall prior knowledge, allow them to synthesize new information, and help guide logical thinking.

It takes some skill to use questioning strategies and to balance the amount of asking and telling in a teaching situation. There's no one formula for what this balance should be, and it changes from situation to situation. Experience and practice can hone instructors' expertise and questioning know-how. Skilled instructors use questions to find out what students think, encourage discussion, and draw attention to diverse viewpoints and interpretations. But even some veteran field instructors don't take advantage of questioning strategies that could elevate their field experiences to interactive learning experiences. Research indicates that instructors who are specifically trained to ask high-quality questions show significant improvement in constructing and using such questions in the classroom (Angletti 1991, as quoted by Cecil 1995).

Connections to Other BEETLES Professional Learning Sessions. This session explicitly focuses on how questions can be used to guide student explorations and discussions. The session, *Promoting Discussion*, looks more closely at how questions and discussion are related, the role of discussion in how people learn, and provides in-depth discussion techniques. The skills and how-to's of actually leading a discussion are covered in the BEETLES *Promoting Discussion*s session. Many programs have found it effective to present the *Questioning Strategies* session, give staff some time to apply it to their instruction, then later follow up with the *Promoting Discussion* session. The *Making Observations* session focuses on how the use of three specific questions can inspire exploration in students, as well as how anthropomorphism and identification can be helpful to or hinder exploration. The *Evidence & Explanation* session focuses on students making observations, asking questions, then making evidence-based explanations.

Questions that Encourage or Discourage Exploration and Discussion

An analysis of questioning strategies can begin with noting the effects of using narrow and broad questions during an exploration or discussion. The model lessons in this session demonstrate how using narrow questions, which have specific, prescribed answers, can shut down exploration and discussion by requiring students to try to guess what the instructor wants them to say. In contrast, using broad questions, which have multiple acceptable responses, can encourage more students to participate and offer various ideas. Of course, narrow questions are very useful for recall and review, which have their place. Once an instructor develops a feel for how these questions affect learners, they can then make thoughtful adjustments to their questioning strategies during their instruction.

Consider Goals When Asking Questions

When planning for questions, another thing to consider is the instructor's purposes or goals for engaging the learner in a particular learning situation. If the purpose is to encourage exploration, it's generally useful to use broad questions to engage students in observing and noticing details. Questions, such as: "What do you notice," "What did you notice when…?" "What do you wonder?" and "What does it remind you of" "Craig, do you agree that the object feels hard and rough?" can be used to guide students to explore while encouraging multiple points of view. Questions, such as: "What do you think will happen if…?" "Do you think there will be more spiders in the chaparral than in the grass?" can be used to stimulate productive activity during an investigation. Once students have explored a phenomenon or performed an investigation, questions can then be used to guide students to make

comparisons or quantify their observations. Given adequate experience and exploration of a topic or phenomenon, students may then be ready to draw conclusions and make sense of their investigations, responding to questions, such as: "What do you think is the explanation for...?" or "Why do you think this happened?" can be used to encourage sense-making. Questions can be used to challenge students to apply what they've learned in order to generalize their knowledge or test their ideas, such as: "how do you think the ecosystem might be affected if sharks were gone?" Asking students to reflect on their thinking—"how have your ideas changed, and what evidence made them change?"—and investigation processes help them become more aware of their own strengths and weaknesses in the subject area, and encourages them to take charge of their own learning.

Role of the Instructor

The final factor considered during this session, which can significantly impact everything an instructor does with students, is how the instructor views his or her role as a instructor. A "sage on the stage" type of instructor has the point of view that it's their responsibility to impart or transmit knowledge directly to students and that the instructor must provide the necessary accurate information for understanding. This view of the learning process can emphasize rote memory and recall of ideas from sources other than the students themselves. The "entertainer" role, common in outdoor schools, is a "fun" version of a "sage on the stage." Both those roles are instructor-centered, not student-centered or nature-centered. Neither of them are focused on encouraging student thinking and deep learning, or at facilitating student relationships with nature. It can be hard to get an instructor to let go of the "entertainer" role, because it's often highly rewarding. It's fun to be the center of attention and make kids laugh and yell chants, and a good entertainer will generally keep students entertained all day, and thus receive kudos from co-workers and classroom teachers. The "entertainer" role certainly has its place in outdoor schools, but if your goal is developing deep learning and a relationship with nature, then instructors need to think about when the "entertainer" role is appropriate, and when it's not. A "guide on the side" type of instructor embodies a more constructivist view of learning—one which accepts that students need to be encouraged to create their own personal frameworks through discussion and interactions with materials and various sources—so they can develop a deeper understanding that can be flexibly applied to different learning situations. The "guide on the side" knows how to be authentic with students, and how to set up experiences and ask questions that will engage students in developing a lifelong thoughtful and inquisitive relationship with nature and learning. And such guides do not generally focus on taking center stage.

Role of the Leader in this Session

This session relies significantly on the leader comfortably asking questions and leading discussions. Using the discussion map (ask a broad question, listen to response and thinking, ask for evidence or explanation, ask for alternate ideas, ask a question that relates back to the main topic, and repeat) can be a useful tool to use during this session. For more guidance on leading discussions and why they are important, review the background section of the *Promoting Discussion* BEETLES professional learning session.

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