beetles

Science and Teaching for Field Instructors

Student Activity Guide

What Scientists Do

Science literacy is of great value for any citizen of the world. For students to develop science literacy, it's important that they not only engage in science practices, but also that they take time to reflect on practices they use, which most students are unlikely to do without scaffolding and support from an instructor. This activity engages students in reflecting on science practices.

This activity has three parts that are meant to be led with students before and after a field experience that includes students engaging in some science practices. The first two parts are meant to be taught at the beginning of a field experience, and the third part at the end of the field experience. In the Science = Adventure introduction, the instructor builds up anticipation and excitement about doing field science. In the Pre: What Scientists Do, the instructor introduces some core field science practices by leading students in using those practices briefly to explore a mysterious object. Later during the Post: Debriefing Science Practices, after other field science experiences (not included in this activity), students reflect back on the science practices they engaged in and experienced.

Students will...

- **Learn about a variety of core practices of scientists**
- **Identify as scientists**
- **Reflect on science practices they have engaged in**
- **Recognize that science can be an adventure!**

Grade Level:
Grades 4-8. Adaptable for younger or older students.

Timing:
about 10 minutes at the beginning and 10 minutes at the end of a field science experience.

Related Activities:
Hand Lens Introduction
Any other BEETLES activity

Materials:
Piece of paper & marker; What Scientists Do diagram on large chart paper (see page 2 and page 7); mysterious object large enough for whole group to see (such as a piece of wood with holes & tunnes or an intriguing skull)

Setting:
Any location where the group can gather and everyone can see the diagram

Tips:
To ensure a successful experience, review the teaching tips found on page 2 and throughout this guide.

NEXT GENERATION SCIENCE STANDARDS

For additional information about NGSS, go to page 8 of this guide.

This activity introduces students to science practices that are most relevant to field science, and to skills that are components of many science practices. This deepens student capacity to effectively engage in science practices to learn Disciplinary Core Ideas and apply Crosscutting Concepts in other activities. Students have the opportunity to build understanding of Disciplinary Core ideas about the Nature of Science.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

What Scientists Do

ACTIVITY OVERVIEW

What Scientists Do	Learning Cycle Stages	Estimated Time
Science = Adventure	Invitation	3 minutes
Pre: Introducing "What Scientists Do"	Invitation	5–10 minutes
Post: Debriefing Science Practices	Reflection	5 minutes
Wrapping Up	Reflection	5 minutes
TOTAL		18–23 minutes

TEACHING TIPS

Field Card. On page 13 of this guide, you'll find a condensed, pocket-sized version of the lesson you can carry along on the hike.

Read Instructor Support Section. Beginning on page 8, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Prepare the large diagram. Draw the diagram found on page 7 on chart paper. Fold the bottom sections under so students don't see them (and get overwhelmed) during the introduction.

Pre- and Post- Assessment. This activity can be used in a variety of ways. (1) Use the first two sections to develop student awareness of science practices at the beginning of a field experience. (2) Lead the *Post: Debriefing Science Practices* section immediately after a particularly "sciencey" experience or at the end of several field experiences. (3) Use a large diagram on chart paper for the group, or (4) Students make a diagram in their science journals. If the diagram is in their journals, students can make different marks next to practices they feel experienced with and those they hope to do. Afterward, students can revisit and change their markings if they feel they've gained experience with a practice. No matter how you use the activity, you can informally assess student understandings of and attitudes toward science practices through each stage.

On "Practices." Throughout this activity, the word "practices" is used to describe to students what scientists do during the process of their work. These are not the same eight science practices in the *NGSS*; here they are intended to represent certain aspects of these practices that are most relevant to student experiences in outdoor science schools.

Science = Adventure

1. **Write "adventure" on a piece of paper.** Tell students to sit on the ground in a semi-circle, where they can all see you. Write "adventure" in the center of the paper, leaving some blank space around the word.
2. **Ask for & record other words that connect with "adventure."** Ask your students to come up with other words that come to mind when they think of adventure [excitement, exploration, discovery, etc.]. As they offer suggestions, write them around the word "adventure."
3. **Replace "adventure" with "science."** Tell students your claim is that these words (or most of them) also describe something else. Cross out the word, "adventure," and replace it with the word, "science." Tell them you'd like to hear whether or not they agree with this claim at the end of the field experience or the end of outdoor science school.

Pre: Introducing "What Scientists Do"

1. **Students *Turn & Talk* about what scientists do.** Tell students to think to themselves about what they've heard that scientists do. After they have a moment to think, tell them to *Turn & Talk* to share ideas with a partner.
2. **Set out large *What Scientists Do* diagram & explain that "science practices" are what scientists do when investigating.** Place the diagram on the ground with only the "Core to Field Science" part showing. Explain: the things scientists do when they are investigating something in a scientific way are called "science practices." At outdoor science school, they'll get to use science practices to explore and learn about their surroundings.
3. **Show object & ask a cluster of students to make observations out loud.** Unveil your mystery object so all can see it. Walk around the circle pausing at a cluster of ~ 4–5 students. Ask, "What do you notice?" Then, give students a chance to briefly observe the object and share their observations out loud.
4. **Explain they are already doing science practices: "Explore" & "Observe."** Point to "Explore" and "Observe" on the diagram, and explain that they are doing these science practices.
5. **Ask a cluster of students to ask questions about the object, then point to "Ask Questions" on diagram.** Move your object along to a different cluster of students, and ask them to come up with questions about the object. After a few questions, point to "Ask Questions" on the diagram and explain that they are doing the science practice of asking questions.
6. **Ask a cluster of students to say what the object reminds them of & make connections between the object & other things in the world.** Move along to a different cluster of students. Ask the questions below, then point to "Make Connections" on the diagram and explain that they're also doing this science practice:
   - ▶ *What does it remind you of?*

TEACHING NOTES

Recording on a whiteboard. You may prefer to do this on a whiteboard, which gives the advantage of being able to erase and replace "adventure" with "science," instead of crossing it out. The disadvantage is that you probably refer back to it at the end of the field experience, because it will likely have all been erased.

See BEETLES *Discussion Routines* for logistics of leading *Turn & Talk.*

Keep it moving. This part of the activity shouldn't drag—give students who are exploring the object a few seconds to do so, tell them which practice they're using, then move on to make sure the group stays engaged.

TEACHING NOTES

- *Where have you seen anything like it before?*
- *What kinds of connections can you make between the object and other things in the world?*

7. **Point to "Discover Science Mysteries" on the diagram & explain they've been doing it.** Explain that everything they just did (exploring, observing, asking questions, and making connections) had to do with discovering mysteries. Tell them the next step is to make explanations based on evidence.

8. **Ask anyone in the group to come up with an evidence-based explanation to answer a question about the object.** Choose what you think might be a good student-generated question to explain, and invite students to come up with explanations based on their evidence. Point out any evidence they include, and if they don't include evidence, remind them to do so.

For example:

- Question: Was the animal a carnivore?
- Student #1 Explanation: I think it was a carnivore, because the teeth look pointy like they'd be good for tearing meat.
- Instructor: So your *explanation* is that it was a carnivore, and that's based on the *evidence* that the teeth are pointy.
- Student #2 Explanation: I think it wasn't a carnivore.
- Instructor: What's your evidence? What makes you think that?
- Student #2 Evidence: Because it has some pointy teeth and some flat teeth, so I think it ate both meat and plants.

9. **After they make explanations, point to "Make Explanations Based on Evidence" on the diagram, & explain they just did it.** Explain that they just did the science practice of making evidence-based explanations.

10. **Tell them that, using these practices, scientists try to come up with the most useful explanations for mysteries in the natural world based on all available evidence.** Explain that this is the overall goal of science, and all these science practices are part of what scientists do to achieve it. There are more practices, but these are the ones they'll be focusing on for now.

11. **Pairs walk & brainstorm other science practices not mentioned yet.** Tell students to each get a partner and, as they are walking, to try to come up with other things scientists do/science practices that were not discussed just now.

12. **Pause & share out a few ideas.** After walking for a couple of minutes, pause, and ask a few to share some of the practices they thought of.

13. **Tell students to try to notice when they are doing science practices during their field experience.** Occasionally point out (or ask students to point out) whenever they're engaging in scientific practices.

14. ***[Optional]* In their journals, students make a check mark on practices**

they have some experience with & star a few that they are particularly interested in doing during the field experience.

Post: Debriefing Science Practices

1. **After other science experiences, return to the diagram showing all sections.** After a particularly "sciencey" experience, at the end of a set of field experiences, and/or at the end of outdoor science school, lay out the diagram again, this time with all the sections showing, and gather students around so they can all see.
2. **Explain the two categories that have been added: "Investigating," & "Applying & Communicating."** Explain that the "Investigating" section includes what scientists do when they design and conduct careful investigations to try to answer questions. The "Applying & Communicating" section includes science practices related to taking what's learned through investigations and applying it to other situations or ideas. That section also includes communicating with others about ideas, investigations, and what has been learned.
3. **Pairs discuss which of these science practices they've done during the field experience.** Divide students into pairs, and ask them to look at all the practices on the chart. Tell them to reflect back on their field experience, and discuss which of the practices they've done. Don't explain each one, because that can be tedious, but if students are confused or curious about any of the practices, share information as needed.
4. **Tell them the arrows show that scientists go back & forth between practices instead of following a series of steps.** Explain that scientists don't follow a specific series of steps. They move between practices, doing what seems to make the most sense to investigate the question they have. There is not just one scientific method. There are scientific ***methods.***
5. **[*Optional*] In their journals, students circle the practices they've been doing.** If students have copies of *What Scientists Do* in their journals, ask them to turn to that page. Ask them to circle any of the practices they engaged in, and/or write a note, like "trying to explain what decomposed the log"—connecting their experiences with the practices.

Wrapping Up

1. **Tell students they've learned science practices that are useful for science, as well as for life in general.** Point out that they have been developing their skills as scientists. Explain that whether or not they ever become scientists, learning to use practices of scientists can be useful in whatever you do in life.
2. **At end of the program, pull out your paper from the beginning, & ask if the "adventure" words seem to fit.** Remind students of some of the words they used to describe "adventure." Ask if they agree that those words also describe the way they have experienced science here. Invite students to reflect on and share experiences from the week of when they were using science practices [at the pond when we observed & drew organisms and

TEACHING NOTES

asked questions about them, during the spider investigation when we made explanations from evidence, etc.].

3. **Encourage students to use science practices & be curious & investigate things wherever they go.** Students can make observations, ask questions, and come up with explanations about anything around them that seems interesting. Just about anything is interesting if you check it out carefully.

4. **[*Optional*] In their journals, students write about science practices they engaged in.** Tell students to take a few minutes to describe what it was like to engage in different science practices, and what they learned from doing them.

WHAT SCIENTISTS DO

Core To Field Science

Explore

Observe

Ask Questions

Make Connections

Discover Science Mysteries

Make Explanations Based on Evidence

Applying and Communicating

Share findings with others
Argue & critique ideas
Solve practical problems
Make & use models & diagrams

Investigating

Plan investigations
Collect data & make measurements
Analyze & interpret data
Use field guides & other resources

NOTES

About the Next Generation Science Standards (NGSS) The development of the Next Generation Science Standards followed closely on the movement to adopt nationwide English language arts and mathematics Common Core standards. In the case of the science standards, the National Research Council (NRC) first wrote a *Framework for K-12 Science Education* that beautifully describes an updated and comprehensive vision for proficiency in science across our nation. The *Framework*–validated by science researchers, educators and cognitive scientists–was then the basis for the development of the NGSS. As our understanding of how children learn has grown dramatically since the last science standards were published, the NGSS has pushed the science education community further towards engaging students in the practices used by scientists and engineers, and using the "big ideas" of science to actively learn about the natural world. Research shows that teaching science as a process of inquiry and explanation helps students to form a deeper understanding of science concepts and better recognize how science applies to everyday life. In order to emphasize these important aspects of science, the NGSS are organized into three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas (DCI's). The DCI's are divided into four disciplines: Life Science (LS), Physical Science (PS), Earth and Space Science (ESS) and Engineering, Technology and Applied Science (ETS).

Read more about the *Next Generation Science Standards* at http://www.nextgenscience.org/ and http://ngss.nsta.org/

INSTRUCTOR SUPPORT

Teaching Knowledge and Connections to the NGSS

Using the "What Scientists Do" Diagram

The NRC's *A Framework for Secondary Science Education* and the *Next Generation Science Standards* list eight practices they advocate for students to engage in and reflect upon in learning science. The BEETLES team developed the "What Scientists Do" diagram to translate some of the practices that are most relevant to learning in the outdoor science school context. The idea is both to inform field instructors on how they might incorporate science practices into their teaching, and to help students better understand and reflect upon science as a process. This diagram does not include every practice described within the *NGSS* Practices. Rather, the practices that are "Core to Field Science" in the circle of the magnifying glass are practices (and skills that are components of practices) that we recommend all outdoor science schools engage students in, throughout the course of their programs. They are also practices field scientists commonly use in their work. These practices are framed in more kid-friendly language than in the *NGSS*, to make them more understandable and accessible to students. Parts of some *NGSS* science practices are broken down into component skills in the diagram, so students can identify these behaviors as essential to engaging in the world in a scientific way.

NOTE: The BEETLES team chose to highlight the practice of observation, which is key to field science (and all science, for that matter). Observation is not absent from the NGSS list because the authors thought it unimportant. Rather, the authors of the NGSS agree that making observations is so crucial to doing science, that it is an essential part of engaging in the science practices they list.

Next Generation Science (& Engineering) Practices

- Ask questions (for science) and define problems (for engineering)
- Develop and use models
- Plan and carry out investigations
- Analyze and interpret data
- Use mathematics and computational thinking
- Construct explanations (for science) and design solutions (for engineering)
- Engage in argument from evidence
- Obtain, evaluate, and communicate information

In the What Scientists Do Diagram, the "Investigating" section is recommended for instructors and programs who want their students to have experiences designing and conducting more formal field science investigations. The "Applying & Communicating" section includes practices related to applying science understandings to other contexts, and communicating about understandings, ideas, and investigations.

Connections to Other Aspects of the NGSS

Most BEETLES student activities are designed to provide opportunities for the "three-dimensional" learning that is called for in the *NGSS*. To experience "three-dimensional" learning, students need to engage in scientific practices to learn important science concepts (Disciplinary Core Ideas), and make connections to the big ideas in science (Crosscutting Concepts). In short, students should be using the tools of science to explore and investigate rich phenomena, trying to figure out how the natural world works.

While *What Scientists Do* does not provide a three-dimensional learning experience, the activity is extremely valuable, as it's designed to deepen student capacity to engage in science practices, learn how science is done, and *reflect* on practices they've engaged in. If students engage in a science practice, but don't reflect on that, they may not even recognize it as a science practice. Students who engage in science practices, but don't necessarily reflect on how this leads to scientific knowledge and understanding, may not realize that these processes and ways of thinking are transferable to important aspects of everyday living. Students who understand science practices in this way are more able to recognize them as useful thinking tools, and put them to good use when faced with questions or scientific problems in the future.

Through participating in *What Scientists Do,* students can also better understand what's referred to in the *NGSS* as "the nature of science." Specifically, as they discuss the practices in the *What Scientists Do* diagram, they build understanding about how scientists use a variety of tools, methods, and techniques to better understand the world. At the end of the activity, when students reflect on the practices they used and what they learned in the process, they come to see science as a discipline that proposes tentative explanations based on evidence.

Conceptual Knowledge

The Significance of Understanding the Nature of Science. In the modern world, we are constantly presented with scientific and non-scientific information. As citizens, we vote on many issues that are informed by scientific studies. To understand the meaning and value of scientific information in these situations, it's important to understand how the scientific field gathers information, and how science makes explanations. The *Next Generation Science Standards* ask students to inquire about the natural world using the inquiry methods that scientists themselves use. Being able to critically inquire about the world will prepare students not only for future science studies, but also for life itself, as they improve their ability to make informed decisions based on evidence and to acquire new knowledge. Teaching students about the nature of science has also been shown to increase student interest in science. Understanding the nature of science is important for citizens and students, and particularly for anyone who teaches science. Science teachers who do not have a background in the nature of science tend to primarily teach vocabulary and facts, while neglecting more important aspects of science,

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From *A Framework for K-12 Science Education*, by the National Research Council (NRC): "Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential... Although the practices used to develop scientific theories differ from one domain of science to another, all sciences share certain common features at the core of their inquiry-based and problem-solving approaches."

Another quote from the *Framework*: "Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Any education that focuses predominantly on the detailed products of scientific labor—the facts of science—without developing an understanding of how those facts were established, or that ignores the many important applications of science in the world misrepresents science..."

About using the term "practices." We refer to scientific "practices," instead of saying "processes" or "skills," in order to emphasize that engaging in scientific investigation requires more than just specific skills. The word "practice" encompasses the application and use of knowledge and ideas in scientific ways.

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The origin of "the scientific method:" "In the 1940s a man named Keeslar wished to describe the different elements of scientists' work. He began by generating a list of all the things he imagined scientists did: carefully making measurements, maintaining detailed written records, defining a research problem. This list was then turned into a questionnaire and given to many professional scientists for their response. Keeslar took the returned questionnaires, put the items receiving the highest rankings into an order that seemed "logical," and published these findings in an education journal. Even though he was reporting on scientists' uses of different thinking strategies without trying to describe a nice neat sequence, that's unfortunately how his work has been used. A science textbook writer saw Keeslar's list and turned it into "The Scientific Method," touting it as THE way science proceeds. Indeed, there is really no such thing as a singular scientific method and this list doesn't accurately portray the work of most scientists (which makes us wonder what teachers are trying to portray by drilling students on the scientific method)." [From Settlage, J. and Southerland, S.A. (2007). *Teaching Science to Every Child: Using Culture as a Starting Point.* New York, Routledge.]

Research on teacher understanding about the nature of science. Science teachers who do not have experiences learning about the nature of science, tend to primarily teach the vocabulary and facts of science. They also tend to neglect the important aspects of science, such as how scientific knowledge is generated, and how knowledge claims are cautiously evaluated. (Gess-Newsome & Lederman, Examining Pedagogical Content Knowledge.)

such as how scientific knowledge is generated, and how knowledge claims are cautiously evaluated. The deeper understanding teachers have of the nature and practices of science, the better they can make this explicit for students. Many children and adults, including science teachers, hold a combination of accurate and inaccurate ideas about what science is. And many science teachers have not had the valuable opportunity of reflecting on the nature of science. The following sections can help you deepen your understanding of the nature and practices of science.

What is Science? Science is an extremely valuable way of knowing. The scientific enterprise is a union of science, mathematics, and technology, as well as logic and imagination. Science assumes that the world around us is understandable, and that the basic rules that exist in one part of the Universe can be applied to others. Like many other systems of thought, science is a quest for truth, yet one of its greatest strengths is that it recognizes that it can never completely arrive at the truth. Nothing is ever completely proven in science. Science is not only open to new evidence and ideas, but actively seeks them out. Science helps us understand the world around us, and in a practical sense, it has great predictive value. Some people think science is infallible. Others see it as a static accumulation of information. Others see it as arrogant, biased, or heartless. In actuality, it's none of these things.

SCIENCE IS...

- **Evidence-based.** In science there are accepted methodologies, standards of evidence, and logical ways of answering questions, all of which are based on using observations, tests, and other types of data to provide evidence. The acceptance or rejection of a scientific idea depends upon the quality of relevant evidence—not upon dogma, popular opinion, or tradition.
- **Making Explanations.** Scientific explanations must show an explicit cause and effect relationship based on observable evidence. They involve looking for patterns and correlations. Scientific explanations specifically describe the natural world, and are not focused on answering supernatural questions.
- **Testable.** If an explanation offers no way to be tested, or does not have the potential to be shown to be false by evidence, it is not scientific. Repeatability of tests is often a standard in experimental types of science. Many branches of science do not solve problems through experimentation, but instead rely on making inferences from patterns and observations that are not necessarily repeatable.
- **Consistent.** A scientific explanation needs to do more than provide a plausible account; it must fit all the observable facts better than alternative explanations. It must be consistent with all available evidence, not just selected evidence.
- **Ongoing and Self-correcting.** Scientists are very careful about what they say they know and how they know it. Science is open-minded, not empty-headed. Ideas are tested and improved by multiple members of

the scientific community, until they are fully accepted. Answering one question can inspire deeper and more detailed questions for further research–the more we know, the more we know what we don't yet know. Scientists are tentative about their findings as they focus on whether the evidence supports or doesn't support their idea. This is a strength, not a weakness, of science. Because scientific ideas are revised and improved on an ongoing basis, science is ultimately self-correcting.

- **Creative.** Creativity is involved in all aspects of science whether it is developing new questions, techniques, explanations or hypotheses. Anyone can have an idea in science; it is non-discriminating and it should not be encumbered by an adherence to tradition.
- **A Product of the Scientific Community.** The scientific community is the people and organizations that generate scientific ideas, test those ideas, publish scientific journals, organize conferences, train scientists, and distribute research funds. This scientific community provides the cumulative knowledge base that allows science to build upon itself. It is also responsible for the further testing and scrutiny of ideas and for performing checks and balances on the work of community members. We must look to the scientific community at large to help ratify explanations and judge the evidence for scientific arguments. Individual scientists may have different agendas and therefore put forth a variety of subjective opinions. Also, scientific experts in one field may not be the best judges of explanations from other fields of science.
- **Conducted through scientific ways of thinking, doing, and communicating.** Science involves using multiple scientific methods, involving varying steps and different procedures. The processes of science are well defined, but are used in flexible and practical ways.

SCIENCE IS NOT...

- **The "Scientific Method."** There is no one method for doing science. Science involves many different steps and procedures, depending on the field of science and the question being investigated.
- **The absolute truth.** Scientific knowledge is only our current best approximation based on all available evidence. In science, no explanations are considered "proven." All explanations are open to replacement or refinement, if warranted by new evidence. Yet much scientific knowledge is durable, and has withstood the test of time and critique.
- **Democratic.** Science is not based on how many people vote for an idea, it's based on the evidence. It doesn't matter how many scientists there are with a particular opinion—the evidence is what counts. It's also not the authority of the scientist, but the quality of the evidence that provides the strength of the argument.
- **Anthropocentric.** In science, we try not to limit our view to only seeing things in nature that are related to human survival. Nature was not made for us, we co-evolved together on this planet with a vast diversity of plants and organisms. Therefore, science avoids making assumptions

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More on the Scientific Method: "What appears to [the working scientist] as the essence of the situation is that he is not consciously following any prescribed course of action, but feels complete freedom to utilize any method or device whatever which in the particular situation before him seems likely to yield the correct answer... In short, science is what scientists do, and there are as many scientific methods as there are individual scientists." (Percy W. Bridgman –"On Scientific Method")

"I would teach how science works as much as I would teach what science knows. I would assert (given that essentially, everyone will learn to read) that science literacy is the most important kind of literacy they can take into the 21st century. I would undervalue grades based on knowing things and find ways to reward curiosity. In the end, it's the people who are curious who change the world."

— Neil deGrasse Tyson

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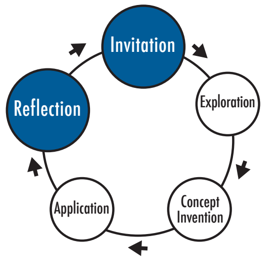

Learning Cycle Stage for This Entire Activity as Part of an Extended Trail Experience

Within a field experience or a sequence of many activities, *What Scientists Do* can be used as both an Invitation and a Reflection.

about particular aspects of nature being in existence just because they may be beneficial to humans, or viewing the behavior of other organisms as reflecting our own intentions and feelings.

Connections to Other Activities

All BEETLES activities engage students in science practices. *What Scientists Do* is a useful pre/post activity because it can help students identify when they use science practices in future activities and learning experiences. Different BEETLES activities emphasize engagement in various practices. The *Routine* category of activities *(I Notice, I Wonder, It Reminds Me Of, Nature Scene Investigation, Discovery Swap, Walk and Talk,* etc.) emphasize the practices "Core to Field Science" and some of the "Applying & Communicating" practices. The *Exploration* category of activities (*Lichen Exploration*, *Spider Exploration,* etc.), also incorporates many of these practices. The *Investigation* category (*Exploratory Investigation, Spider Investigation,* etc.) models one way to engage students in "Investigating" practices.

FIELD CARD

Cut out along outer lines, & fold along the centerline. This makes a handy reference card that will fit in your pocket.

What Scientists Do

Science = Adventure

1. Write "adventure" on a paper.
2. Ask for & record other words that connect with "adventure."
3. Replace "adventure" with "science."

Pre: Introducing "What Scientists Do"

1. Students *Turn & Talk* about what they think scientists do.
2. Set out large "What Scientists Do" diagram & explain that science practices are what scientists do when investigating.
3. Show an object, & ask a cluster of students to make observations out loud.
4. Explain they are already doing science practices: "Explore" & "Observe," & point these out on the diagram.
5. Ask a cluster of students to ask questions about the object, then point to "Ask Questions" on the diagram.
6. Ask cluster of students to say what the object reminds them of, then point to "Make Connections" on the diagram.
7. Point to "Discover Science Mysteries" on the diagram & explain they've been doing it.
8. Ask anyone in the group to come up with an evidence-based explanation to answer a question about the object.
9. Point to "Make Explanations Based on Evidence" on the diagram & explain they just did it.
10. Tell them that, using these practices, scientists try to come up with the most useful explanations for mysteries in the natural world, based on all the available evidence—this is the overall goal of science.
11. Pairs walk & brainstorm other science practices that have not been mentioned yet.
12. Pause & share out a few ideas.
13. Tell students to try to notice when they are engaging in science practices during their field experiences.
14. [*Optional*] In their journals, students make a check mark on practices they have some experience with, & star a few they are interested in doing during the field experience.

Post: Debriefing Science Practices

1. After other science experiences, return to the diagram, showing all sections.
2. Explain the two categories that have been added: "Investigating," & "Applying & Communicating."
3. Pairs discuss which of these science practices they've done during their field experience.
4. Tell them the arrows show that scientists go back & forth between practices, instead of following a series of steps.
5. [*Optional*] In their journals, students circle the practices they've been doing.

Wrapping Up

1. Tell students they've learned science practices that are useful for science, & for life in general.
2. At the end of the program, show "adventure/science" paper again, & ask if the "adventure" words seem to fit.
3. Encourage students to use science practices & be curious & investigate things wherever they go.
4. [*Optional*] In their journals, students write about science practices they engaged in.

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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