beetles

Science and Teaching for Field Instructors

Student Activity Guide

Nature Scene Investigators: NSI

This activity sets an exciting tone of exploration and discovery, encouraging an inquiry mindset in students that helps establish a community of curious, active learners. Students gain tools to explore the natural world—and are inspired to discover and attempt to explain the abundant nature mysteries that surround us. NSI works well at the start of a field experience, to get students excited about nature mysteries. It provides an opportunity for an instructor to coach students in inquiry skills, by using the language of science and engaging in scientific discussions. For instructors with less experience leading open-ended explorations and discussions, this can be a challenging activity to lead successfully the first time. The write-up includes detailed support, by providing information and strategies for the instructor. Students focus on a mystery object, generate observations, questions, evidence-based explanations and share what they already know from other sources. Once students are familiar with these practices, they can use them to investigate and make explanations about anything they find in nature through their field experience(s).

Students will:

- **Formulate their own observations, questions, and explanations from evidence about what they find in nature.**
- **Participate in a scientific discussion using language of uncertainty.**
- **Learn that not all sources of information are equal.**

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

Timing:
About 40-45 minutes

Related Activities:
I Notice, I Wonder, It Reminds Me Of
Thought Swap

Materials:
For instructor: Mysterious, natural object; *Optional:* Student Resources (page 15); Instructor Resources (page 16).
For each student: (optional) 1 hand lens.

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

Setting:
At hike intro site, or anywhere students can comfortably circle around a mysterious object.

NEXT GENERATION SCIENCE STANDARDS

For additional information about NGSS, go to page 11 of this guide.

FEATURED PRACTICES	FEATURED CROSSCUTTING CONCEPT	DISCIPLINARY CORE IDEAS
Constructing Explanations	*(Optional)* Cause and Effect	DCI's will vary depending on students' focus and the guidance of the instructor.

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Exploration Routine

Nature Scene Investigators:NSI

ACTIVITY OVERVIEW

Nature Scene Investigation	Learning Cycle Stages	Estimated Time
Introducing NSI	Invitation	**5 minutes**
Making Observations & Asking Questions	Exploration	**10 minutes**
Making Explanations from Evidence	Concept Invention	**5 minutes**
Sharing & Evaluating Information from Other Sources	Application	**5 minutes**
Applying the Skills & Inquiry Fever	Application	**10–15 minutes**
Wrapping Up & Making Connections	Reflection	**5 minutes**
TOTAL		**40-45 minutes**

TEACHING TIPS

Field Card. On page 17 of this guide, you'll find a condensed, pocket-sized version of the lesson for field use.

Choosing the Right Object. This is key! *NSI* works best with an object that's mysterious and unfamiliar to students, so they're excited to come up with lots of observations, questions, and explanations. Objects like weird looking shelf fungi, large galls, rotting logs, skulls, or burls work well. Make sure the object is large enough for the whole group to see at once, and have it ready to go before the field experience. Ideally, the object should be from the area, not exotic. It's helpful to know a bit about the object so you can more effectively guide discussion.

Prepare students for success in discussion. Successful *NSI* takes practice for instructors & students. Consider teaching *I Notice, I Wonder, It Reminds Me Of* first so students know how to make observations and ask questions. Consider printing out the optional *Examples of Things to Observe & Ask Questions About* & *Using Language of Uncertainty* (page 15) as visual aids to help students formulate statements and questions.

Prepare yourself for success in discussion. This write-up has scaffolding to help you prepare to lead discussions and engage all students in the process by asking broad questions and encouraging responses. Check out BEETLES resources on leading discussion for additional support.

The NGSS crosscutting concept of Cause & Effect has been integrated into this activity. Depending on your goals for students, you could substitute a different cross-cutting concept, or to skip these optional steps.

Introducing NSI

1. **Tell students there are mysteries everywhere in nature!** Say that a lot of people walk through nature without noticing much–but there are mysteries everywhere in nature—if you pay attention.
2. **Explain that, if you know how to observe, ask questions, & make explanations, nature is exciting & interesting.** Say that once they know these skills they need never be bored in nature.

   ▶ *You'll be a team of Nature Scene Investigators checking out a mystery object.*
3. **Students form two concentric circles facing inward, with inner circle sitting/kneeling.** Half the group sits or kneels in a tight circle. The other half stands in a circle immediately behind them.
4. **Explain role of inner circle: making observations.** The inner circle says observations out loud so everyone can hear them. They will also examine the object closely (using hand lenses if available).
5. **Explain role of outer circle: asking questions about the object.** Tell outer circle to try to ask questions that can be answered through observation by the inner circle. All relevant questions are encouraged, but questions that can be answered through direct observations–the way the object smells, feels, looks, sounds–are especially useful. Steer students away from identification questions. If "what is it?" questions pop up, tell them they'll get to that later, but for now they should focus on information they can gather from their own observations.

Making Observations & Asking Questions

1. **Unveil the mystery object & set it in center of circle.** Up till now, keep your mystery object concealed in a bag or cloth to build suspense and to make sure students are focused while you're giving instructions.
2. **Tell the inner circle to make observations & the outer circle to ask questions.**
3. **Facilitate this stage of the discussion by encouraging participation, interaction, observations, questions, and conversation.**
   - **To encourage participation establish non-verbal signals for agreement.** Invite students to pat their heads or use an established hand signal if they notice or wonder the same thing someone else says.
   - **To encourage interaction, include the outer circle.** If a question from the outer circle can be answered through observation, ask students in the inner circle if they can answer the question (especially those close to the object). The more you can focus the inner circle on questions asked by the outer circle, the more you can engage the outer circle. Focus on questions that can be answered through observations. To support the outer circle in generating questions, ask them to pass around the card *Examples of Things to Observe & Ask Questions About*

TEACHING NOTES

Your excitement matters. Carry a genuine sense of excitement and curiosity—both about your mystery object and what your students have to say. Your attitude can inspire—or squash—student energy for exploration and thinking.

Coach adults to participate. Talk in advance to any adults coming with the group about actively participating in the activity along with the students. Encourage adults to be engaged, to state observations and ask questions, (without taking over). Suggest that they mostly restrain themselves from sharing their knowledge, but their enthusiastic participation helps create a shared culture of inquiry.

***NSI* can be messy; Don't be strict.** Some outer circle students will call out observations and some inner circle students will call out questions. That's fine. Focus on following interest and including as many students as possible.

Using *I Notice, I Wonder, It Reminds Me Of* skills. It may be useful for students who are struggling with making observations to give them the sentence starter "I notice..." and encourage them to say out loud anything they notice and to add to others' observations. Similarly, students struggling to ask questions can use the sentence starter, "I wonder...".

Talking over each other? If students are calling out too many observations and questions at the same time, and it's difficult to hear one another, ask them to slow down and wait for pauses. Last resort: ask them to raise hands.

TEACHING NOTES

More questions to encourage observations. *What can you notice using your other senses? How would you describe the other side?*

Facilitate student interaction, thinking, and participation. Asking specific students to agree or disagree with observations encourages deeper observations and respectful disagreement. Try to stir up student-to-student discussion by pointing out interesting student statements and asking others to respond to them. Encourage a shy or reluctant student to participate by asking low-risk questions, such as, "Do you agree that there are holes in it, Lauren?"

Don't let it drag. Pay attention to group interest and energy, and keep things moving! One of the main goals is to make students curious, and boredom is counter-productive.

Remember to be a "guide on the side." Play the role of "guide on the side," managing the dialogue, encouraging participation, and helping students clarify their statements. Avoid sharing information you have about the object until after students have investigated the object(s) on their own and made their own explanations. If you wait, the facts and ideas you share are more likely to be understood and be memorable because students will be more curious and involved in figuring things out.

(page 15) and use it to come up with ideas for questions.

- **To encourage observations and questions, use prompts like:**

▶ *What do you notice?*

▶ *What colors do you see? Textures?*

▶ *Is it heavy or light?*

▶ *How would you describe its shape?*

- **To encourage dialogue and discussion, use prompts like:**

▶ *Isaiah, do you see the holes, too?*

▶ *Do you agree with what Bernice said?*

▶ *Sarah, how would you describe the color?*

▶ *What do you think, Juan?*

4. **Before students lose interest in the object, ask the circles to switch places.** After a few minutes but *well before* student interest wanes, have the inner circle switch places with the outer circle.
5. **Say that everyone should make observations & ask questions.** Tell them that at this point anyone can call out observations or ask questions—no matter which circle they are in. Make sure everyone who was previously in the outer circle gets a chance to look at the object up close.
6. **Facilitate this stage of the discussion by focusing students on an intriguing part of the object & helping them build on one another's observations to encourage discussion.**

- **To help students focus on one part of the object, follow their interest, and ask "going deeper" questions, like:**

▶ *We've noticed this pattern of it being light on top and dark on the bottom—is there anywhere on the object it's not like that?*

▶ *Are those colors everywhere, or only in certain areas?*

▶ *What true statements can you say about the cracks?*

- **To help students build on one another's observations, ask questions like:**

▶ *Does anyone want to build on what Carla was saying?*

▶ *Roberto showed us that these holes go all the way through this object. What else can we notice about them? Are all the holes like that?*

▶ *What else can we notice about that side of the object?*

Making Explanations from Evidence

1. ***Well before*** **students lose interest, invite them to make explanations**

based on evidence (more observations & questions always welcome!). Ask students in both the inner and outer circle to start coming up with explanations based on evidence. Often students will start to do this naturally, and you can use a student's example to segue into this step. For example:

▶ *OK, now let's move on to what Isaiah has already started doing, when he said he thought the white part was the top when it was alive. Can anyone else come up with an explanation for which side is up, whether it was burned or not, where it came from, or any other things we've wondered about? And remember to share the evidence your explanation is based on.*

2. **Facilitate this stage of the discussion by following students' interests, encouraging good science talk, & asking questions that encourage explanations, promote dialogue, & uncover student thinking.**

- **To follow their interests, seek out their excitement, and follow it as they make explanations.** Be ready to shift focus if interest in a certain trait or idea wanes.

- **To encourage good science talk, ask them to share their evidence and define any big words**. If a student makes an explanation without evidence, ask for the evidence. If a student uses vocabulary others may not know, ask them to describe what they mean by the word.

- **To encourage good science talk, ask students to respectfully agree or disagree with each other's ideas, and use "the language of uncertainty."** Use student statements to introduce language of uncertainty. When a learner begins a statement with "Maybe," "I wonder if," or other language of uncertainty, point this out to the group. Explain that it's a good example of how you talk in science, and being open to the possibility there may be a better explanation. Bring the "Language of Uncertainty Sentence Starters" (page 15) and hold it up during the discussion to help students form their sentences.

- **To encourage explanations, ask questions like:**

▶ *We've wondered about __________; what's an explanation for it?*

▶ *So Sarah, you said that you saw different colors on different sides of the object. What's your explanation for that?*

▶ *What do you think has happened to it?*

▶ *What could have caused this?*

- **To encourage dialogue and uncover student thinking, ask questions like:**

▶ *What's your evidence for that?*

▶ *Would anyone like to add to that explanation, or come up with a different explanation?*

▶ *What makes you think that?*

TEACHING NOTES

Seek out the edges of your own & your students' understanding. We become curious about things we don't know. Guide students towards mysteries they don't understand. Don't be afraid of student questions to which you don't know an answer. Inquiry and discussion become more authentic and interesting when the whole group, including you, is sincerely trying to figure something out.

Ask broad, not narrow questions. For the most part, try to ask broad questions-—or, in other words, questions that have multiple possible responses. This leads toward exploration and thinking. Try to avoid questions that have one correct response (called "narrow questions"). Narrow questions are good for helping students recall what they already know, but generally not for generating exploration and thinking.

More questions to encourage explanations:
Which side do you think was up? Where did this object come from?
Has this object been altered by outside forces?
How long do you think it has been that way?
Do your observations back up that idea?

TEACHING NOTES

Introducing the Optional Crosscutting Concept. The optional steps here are for instructors who want to integrate the *Next Generation Science Standard* (NGSS) crosscutting concept of Cause and Effect into this activity. For students to appreciate this big idea of science, they'll need to have multiple experiences with using this lens to explore nature. See the Instructor Support section for more information about making connections between this activity and the NGSS.

Scientific explanations and non-scientific explanations. If students come up with non-scientific explanations (such as, "aliens did it," "God made it that way," or "it's beautiful to make humans happy"), help them recognize that these explanations are not scientific because they aren't based on evidence we can observe. Let students know that during this activity they are going to focus on making scientific explanations that are based on evidence they can directly observe.

Informal assessment check-in. Listen as students make explanations. Notice if they're citing evidence for their ideas, using language of uncertainty, and naming sources of information. Also, pay attention to conceptual ideas students share to gauge their levels of understanding, and to guide your instructional choices throughout the field experience.

- *So, Isaiah thinks something may have eaten it because of these small holes. What do you think of that idea, Juan?*
- *So Roberto, you said you think this object fell on the ground at some point because of the damage you observed. Is that right? Does anyone want to build on what Roberto said?*

3. **Keep discussion moving & transition when students are ready.** If it seems appropriate, redirect the conversation by asking a new question or checking in with the group.

4. ***Optional Crosscutting Concept:* Explain to students that many features we observe in the natural world are the "effects" of one or more causes.** Explain that things they observe in the natural world—like some of the features of this object—were *caused* by something. In other words, many observations can be called "effects" and whatever produced them can be thought of as the "cause."

5. ***Optional Crosscutting Concept:* Explain that although we can't always "catch the causes in the act," we can still make possible explanations for what might have happened.** We can try to figure things out using evidence and reasoning. Trying to connect the possible causes with effects can be fun and interesting.

Sharing & Evaluating Information From Other Sources

1. **Invite students to share what the object reminds them of, what they know or have heard, & name their sources.** Say that now they'll have a chance to share what the object reminds them of, and what they may have heard or already know about the object. To be scientific, they should also name their sources—say where they got their information—like from a book, what a friend said, from a website, etc.

2. **Encourage them to share how reliable they think their sources are.** Explain that sources can be more or less trustworthy. It's important to cite sources for the information we share about a topic, and to discuss how reliable we think the sources are.

3. **Ask questions to encourage student sharing, such as:**
   - *What does it remind you of?*
   - *Where have you seen something like this before?*
   - *Have you ever heard, seen, or read anything about something like this?*

4. **After students have the chance to share their knowledge, you can share relevant information you know about the object & include your source(s).** Try not to share everything you know about it. If there's information that could incite more curiosity, go ahead and share it, but only ***after*** students have shared their own knowledge. If they can discover things for themselves during further explorations, don't spoil their inquiry spirit by *telling* them now. Think about facts that are relevant to what they're focused on and might push their observation deeper or corroborate (or cast some doubt on) what they've already figured out. For

example, you could say:

- *Based on your observations and explanations, you all thought this leaf was damaged by insects eating it. I've seen photos of this sort of pattern in a section on leaf damage by caterpillars, in a field guide called "Tracks & Sign of Insects," and since caterpillars are insects, that supports your explanation. During our hike, let's keep looking at this type of leaf, and see if we can find more evidence, or actual insects in the process of eating them.*

Applying the Skills & Catching "Inquiry Fever"

1. **Explain that they can apply what they've learned *anywhere* in nature.** Now that they know how to make observations, ask questions, and make explanations, they can learn about any part of the natural world.
2. **Take students to an area rich for exploration & to explore & use their skills with others.** Tell them to find interesting stuff, and along with others, make observations, ask questions, and try to explain what they've found using evidence.
3. ***Optional Crosscutting Concept:* Encourage students to make explanations about possible causes for things they observe.**
4. **Offer tools, like cups, nets, bug boxes, & hand lenses, & send students to check out interesting things using their "NSI" skills with others.**
5. **Move between groups & help engage students who may be less focused or don't know what to do.** Give students time—at least 10 minutes—so they can find something that interests them and have meaningful conversations about it. Circulate and ask questions to engage students, such as:
   - *What do you notice about this?*
   - *What are some questions you have about it?*
   - *What's your explanation for that?*
   - *What's the evidence for your explanation?*
   - *What do you think about that explanation?*
   - *Can you come up with a different explanation?*

Wrapping Up and Making Connections

1. **Ask what it was like to use science inquiry skills in nature.** Encourage students to reflect on the science skills they just used, and what that was like for them.
2. **Tell students to keep looking for mysteries in nature & using their tools—during the field experience, but also beyond it.** Say they can keep using these skills to explore interesting things they notice during the field experience, or wherever they go—even a schoolyard, at home in their yard, or in a park. Tell them to look around at how many more potential mysteries there are to investigate in the natural world. Remind them that

Inquiry Fever. "Inquiry fever" is a term we use to describe when a group of students is enthusiastically investigating nature, feeding and building on each other's discoveries, ideas, and enthusiasm. *NSI* is designed to set students up with an inquiry mindset and skills. Add the other two ingredients, and your students can catch the fever. The three ingredients necessary for inquiry fever are:

- **inquiry mindset and skills**
- **permission and encouragement**
- **interesting stuff and/or ideas**

TEACHING NOTES

the way they made observations, asked questions, and came up with explanations is very similar to how field biologists work.

3. ***Optional Crosscutting Concept:* Encourage students to make & discuss explanations, coming up with possible causes for effects they observe.** Tell them this a useful way for scientists to learn about many parts of the natural world.

   - *When we find interesting stuff in nature, lets keep trying to figure out what caused it. Scientists think about cause and effect whenever they're trying to figure something out, because it helps them better understand the world.*

4. **If your object is commonly found at the site, encourage students to look for other examples to investigate further.** For example:

   - *Maybe someone can spot a bird like the one that was killed, or an animal that might have killed it.*
   - *Let's see where we find these fungi living in the woods, and if they grow on wood or on the ground.*

"Running mysteries." Ideally, your group will still have questions about the object once NSI is done, that will draw them into more investigating and questions during the field experience. For example, students who had puzzled about which side of a bracket fungus was up, were able to immediately answer the question when they found some on a dead stump—and then moved on to their next question to investigate, "do they only grow on dead wood?"

5. **Make connections to your theme and/or concepts.** Transition into the activities that follow *NSI*, by reminding students about your theme for the day/hike/field experience, and helping them relate the topic to their investigations and explanations. Invite students to make more observations that connect to what they've discovered through *NSI*. For example:

   - *I wonder how many galls we can find on our hike today and if they will be similar or different from this one. Where do you think we might find more?*
   - *Let's keep looking for more evidence of predator-prey interactions.*
   - *That was an organism adapted to survive in a damp forest. Maybe we can compare it to an organism from a dry habitat.*

Instructor Support

Teaching Knowledge

Leading *NSI* Successfully. Instructors with little experience leading open exploration and discussions may struggle with leading *NSI* at first, and may benefit from trying more straightforward science discussion and exploration activities, such as *Thought Swap* (formerly known as *Walk & Talk*) and *I Notice, I Wonder, It Reminds me of.* This activity works best when the instructor can "read" the group, improvise prompts to increase participation and curiosity, help guide students to build on each other's ideas, explore the quality of evidence, and discuss ideas; teaching skills which take some experience to master. A smooth presentation of *NSI* may seem quite simple to an observer, but there's a lot going on. The skillful instructor guides the action by inserting just-the-right prompt at just-the-right moment. As with any unscripted activity, instructors have to be ready to follow student ideas that can go down unpredictable pathways. These scientific practices/skills are important for students to engage in; it's important for field instructors to learn how to lead these types of evidence-based discussions in order to become successful at teaching science. An outdoor science school provides a great setting for trying out, practicing and developing these discussion skills. If the activity doesn't work perfectly the first time you lead it, that doesn't mean you should never try it again. Pay close attention to the "surround" and scaffolding in the activity write-up, which is meant to coach instructors to be successful with leading the activity. Try to figure out small adjustments to implement instead of tackling everything at once.

The Learning Cycle and *NSI*. *NSI* completes a full learning cycle. The Invitation is when you engage students in exploring the mystery object. Exploration takes place as they make observations and ask questions. Concept Invention begins early and remains the focus as they make and discuss their explanations, and cite any prior knowledge. Application takes place during Inquiry Fever, and during other opportunities in the field experience where students can use these investigation skills. Reflection happens when you ask students to reflect on their experience at the end of the activity.

Pacing for This Activity. This activity requires careful attention to student interest and energy on part of the instructor. Any phase of the activity can be shortened if the group is lacking interest or lengthened if they are deeply engaged in an idea or characteristic of the mystery object. Sometimes students in the outer circle don't have ideas of what sorts of questions to ask, which can cause the activity to seem like it's dragging. Consider printing the optional *Examples of Things to Observe & Ask Questions About* (page 15) and offering it to students as a reference if they run out of questions to ask.

Language of Science. Science is about coming up with the best explanation based on all the available evidence. Scientists also should be open-minded about other explanations that could be better. That's why scientists tend to use language of uncertainty when discussing ideas and explanations. Try to use sentence starters like, "Maybe..." "I wonder if..." "That evidence makes me think..." "The evidence seems to show..." and encourage students to phrase their statements in similar language. Some scientific explanations, like

TEACHING NOTES

What are the benefits of doing *NSI*?

* Provides students with a lens and a mindset, which they can use to engage with nature on a hike, and whenever they are in the outdoors.

* Everyone can see the "find" at all times, and everyone has an opportunity to explore it up close.

* Everyone gets a chance to focus on observations, questions, explanations and connections.

* Without being given "pat" answers, kids are intellectually engaged: inciting curiosity, wonder, thinking, etc.

* Students become aware that there are mysteries everywhere in nature which can generate interest in nature.

* The leader has the opportunity to coach the whole group on collaboration, scientific discussion/argumentation, language of uncertainty, open-mindedness, making explanations from evidence, citing sources and judging how reliable they are.

* engaging in argument from evidence, building collaborative understanding, etc. are important life skills!

Using NSI during field experiences. Use NSI approach & inquiry skills as much as possible, but don't overuse the formal version with concentric circles, and changing roles. The formal version works best as an introduction to inquiry skills and mindset, followed by inquiry fever. It arms students with curiosity and skills for making explanations that can be used at any time informally during a field experience- not just in the structured concentric circle format. Consider using the formation again only if there is a particularly interesting find that your whole group wants to explore, such as an interesting carcass. If over-used, students rebel against the structure. Narrow trails are not conducive to the concentric circles formation.

TEACHING NOTES

Spanish translations for some language of science. These words tend to be pretty easy for Spanish speaking English language learners, because they are cognates, which are similar to words used in Spanish and other "romance languages." Evidence = evidencia, Explanation = explicación. Data = los datos. It's sometimes said that "cognates are seen, not heard," because the way they are spelled is often more similar than the way they sound. That's why it's useful to spell out cognates for English language learners, when possible.

Taking *NSI* home. *NSI* provides students with curiosity and skills for exploration they can use at home in a park or their yard. Before the end of the field experience, ask them where there are places they might do *NSI* back home, and encourage them to keep doing *NSI* on their own.

"we live on a planet," have so much supporting evidence that it's appropriate to use language of much more certainty when talking about them. To aid students in practicing language of uncertainty, consider printing the *Using Language of Uncertainty* (page 15) sentence starters, and holding them up during the "Making Explanations" part of the activity, so students can reference these phrases as they speak. Some students have more exposure to the language of science and other academic language at home and through informal science education opportunities, such as science centers, museums, and after school programs. Other students grow up with less access to language of science. These students tend to struggle with science in later grades, which some blame on this lack of exposure and practice with the language of science. Providing students with exposure to, and practice with talking about evidence, explanation, and language of uncertainty, promotes equity by helping all students with success in science.

Supporting English Language Learners. Making explanations about interesting real objects can be very productive for language development. Sentence starters can help support students in their primary language and in English.

Questioning strategies. When encouraging discussion it is important to use "broad" questions instead of "narrow" questions. There are different categories of broad questions that are useful during different stages of *NSI*—some that encourage more observations, others that involve multiple students in the discussion and still others that urge students to build on each others ideas. Page 16 includes examples of questions and how they could support facilitating a discussion during *NSI*. Many of these questions are included in the Field Card for reference while running *NSI*, especially the first couple of times.

Conceptual Knowledge

In this activity, conceptual knowledge will differ depending on the chosen object. The instructor doesn't need to be an expert about the object for *NSI* to be successful- but some knowledge of the object is useful so the instructor can facilitate a productive discussion. The instructor should be ready to encourage students by asking the right question or offering a bit of content at a critical point in the discussion. Often there is a point when students can't find out any more information just by looking more and a key question will remind students to remember what they have already observed and to use the information available to them. For example, an instructor leading an *NSI* of a tree branch with a gall on it could say "A few of us have made observations that have led them to think that this part of the branch appears to be made of the same material as the rest of the branch. Is there anything we can think of in the environment that could have caused this? What evidence of changes can we see?"If the instructor didn't know what caused galls it could be more challenging to come up with productive questions.

But asking a pointed question or offering a small piece of information is different from just telling students everything about an object or answering a question right away without offering any space for discussion or debate. A statement like "broad, flat teeth are often used for grinding plants. Do these teeth look like plant-grinders?" invites students to observe more and come up with their own explanations that confirm or deny what the instructor has said. Whereas making a conclusive statement like "this animal skull is from an animal that eats plants because the teeth are broad and flat for grinding up those plants," may discourage students from investigating the object themselves.

Connections to the Next Generation Science Standards (NGSS)

BEETLES student activities are designed to provide opportunities for the "three-dimensional" learning required in the NGSS. To experience three-dimensional learning, students need to engage in Science Practices to learn important science ideas (Disciplinary Core Ideas) and deepen their understanding by relating that content to overarching Crosscutting Concepts. Students should be exploring and investigating rich phenomena, and figuring out how the natural world works.

NSI: Nature Scene Investigators, engages students in the practice of *Constructing Explanations* and introduces the crosscutting concept of *Cause and Effect*. NSI can provide an opportunity for students to develop some foundational understanding of science concepts, but the specific DCI's students consider will vary depending on the natural phenomenon students explore, the observations they focus on, their prior knowledge, and the guidance of the instructor.

Featured Science and Engineering Practices

Engaging students in Constructing Explanations. According to *NRC's A Framework for K-12 Science Education*, a major goal of science is to deepen human understanding of the natural world through making explanations about how things work. It follows that students should develop their understanding of science concepts through making their own explanations about natural phenomena. The encouraging news is that, with a bit of focused training, it's possible to look at any observable part of the natural world—holes in a leaf, patterns of erosion, animal scat, tree branches—and construct possible scientific explanations based on the available evidence.

In *NSI: Nature Scene Investigators*, students focus initially on making observations and asking questions about a mystery object. Though students aren't necessarily making explanations during these steps, observations and questions are critical to the success of the activity. As students make observations, they develop interest and experience with the object as a group, and they gather empirical evidence that can be used later, when they actively begin making explanations. When your group transitions from making observations to constructing explanations, be sure to emphasize that they need to include evidence in their statements about what's going on and why. If an instructor skips this step, students can be tempted to jump directly to making explanations without thoughtfully considering the evidence. Coach students on citing their evidence and using the language of uncertainty ("I think that... maybe...,") in the large group discussion, reminding them to be open to other

beetles

TEACHING 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/

possible explanations that could fit the evidence. Using tentative language and connecting explanations to evidence, are critical aspects for students fully engaging in this practice.

Connections to other science practices, including Common Core (Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects). The following three "practices" are shared by *NGSS* and the Common Core English Language Arts standards: (1) Read, write, and speak grounded in evidence; (2) Construct viable arguments and critique reasoning of others; and (3) Engage in argument from evidence. When students practice making evidence-based explanations in *NSI*, they are developing skills that will support their abilities in language arts and math, as well as in multiple scientific practices. During *NSI*, when students are discussing and comparing their explanations in order to come up with the best one, students are building abilities important for the science practice of *Engaging in Argument from Evidence.* Through participating in *NSI*, students also get practice asking questions that can be answered through more observations or investigations, which is a key aspect of the practice of *Asking Questions.*

Featured Crosscutting Concepts

Learning science through the lens of Cause and Effect. When scientists make explanations for how or why something happens, they are thinking about the connection between cause and effect. Much of what we can observe of the natural world are the "effects" of many potential "causes." Understanding cause and effect relationships, leads to a deeper understanding of the world, which is helpful in making predictions and scientific explanations about what might happen as a result of similar conditions in the future.

In *NSI*, when students make possible explanations about specific features of the mystery object and how they came to be, they're thinking about what might have caused the effects they've observed. Yet, students aren't introduced to the language of "cause and effect" unless the instructor presents the optional steps that describe how features are "effects," and making explanations is a way of thinking about possible "causes" of those effects. If these steps aren't included, students won't necessarily connect what they're doing in the moment, to this "big idea" that's often used by scientists. They may not realize that this is a useful lens or mindset that they themselves can use anytime they are trying to make sense of something. To help students recognize the utility of this crosscutting concept, make sure to include the optional steps from the write-up and explicitly point out that analyzing cause and effect relationships is an approach scientists also use when trying to decipher the mysteries of the natural world.

Learning science through the lens of other crosscutting concepts. Though specific language around *cause and effect* is integrated into this write up, other crosscutting concepts could be used in this activity, if you have a different theme or alternative learning goals for your students. Students can make different kinds of observations and explanations depending on which crosscutting concept you introduce to them. Those explanations should relate to the important concepts you want to emphasize. For example, students who use the crosscutting concept of *structure and function* while making explanations

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Quote on argumentation from NGSS. "In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated." - *Next Generation Science Standards*

Importance of teaching science practices. "Engaging in the practices of science helps students understand how scientific knowledge develops...It can also pique students' curiosity, capture their interest, and motivate their continued study..." -National Research Council, *A Framework for K-12 Science Education.* Focus on these science practices will help to ensure a more scientifically literate public who will be better able to make thoughtful decisions.

About Crosscutting Concepts in the NGSS. Crosscutting concepts are considered powerful thinking tools for how scientists make sense of the natural world. The seven "big ideas" listed as crosscutting concepts are: Patterns; Cause & Effect; Scale, Proportion & Quantity; Systems and System Models; Energy & Matter: Flows, Cycles and Conservation; Structure & Function; and Stability & Change. These concepts may sound familiar, as they are quite similar to the themes referred to in science literacy documents as being important ideas that unify all disciplines of science and engineering.

about a skull, can begin to develop understanding of concepts related to adaptation. Make a decision about which crosscutting concept to include based on your learning goals for students, and point out to students that it's a "big idea" that will guide their thinking during their field experiences. Provide additional opportunities where they can continue to think about the crosscutting concept involving different scenarios, so that they can recognize its broader use in science.

Featured Disciplinary Core Ideas

Building an understanding of Disciplinary Core Ideas. The *NGSS* make it clear that students need multiple learning experiences to build their understanding of disciplinary core ideas. Depending on how you use this activity to lead into and support additional field experiences, *NSI: Nature Scene Investigators can* provide students with an opportunity to build understanding of DCIs.

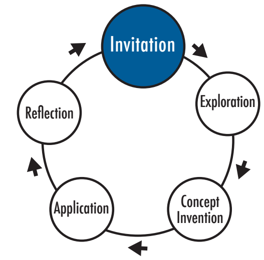
The specific DCIs students learn about will vary depending on what they are investigating, the observations they happen to make, their prior knowledge, and the guidance of the instructor. Consider choosing an object that can generate interesting questions or explanations, and that relates to the DCIs you wish your students to understand better. However, try not to discourage them from focusing on aspects of the mystery object that might be unrelated to your concept goals. The main purpose is to help students become more curious and develop their science practice skills. Regardless of the object or which kinds of observations students make, they can learn specific information about the object while engaging in scientific practices.

NSI can help students build toward conceptual understanding, by providing experiences that prepare them for follow-up activities. In the early part of the activity, students can make observations that relate to bigger concepts, but the main opportunity for expanding their understanding is through making explanations and sharing information from other sources. For example, if they examine an oak gall and observe there are holes of different sizes on it, they've made some concrete observations about the characteristics of this interesting artifact. When they offer the explanation that the holes may have been made by organisms of different sizes, they add to their understanding of how living and non-living parts of an ecosystem interact.

This understanding can be taken further when an instructor shares additional information during the *Sharing and Evaluating Information* section. This is one reason why it's helpful to research the object beforehand, so you're prepared to share content and respond to questions that support the DCIs you want students to focus on during the field experience. To ensure that students build understanding of Disciplinary Core Ideas, provide repeated opportunities to engage with and explore the topic in various ways, through additional activities. The *Wrapping Up and Making Connections* phase is a chance to connect their explorations of the object to the rest of your field experience, and prepare students to engage in more meaning-making activities.

Activity Connections and Additional Ideas

One of the main goals of *NSI* is to provide students with a deeply engaging experience, in which they enjoy "acting like scientists," while investigating



NSI: Nature Scene Investigators: **completes a full learning cycle as a discrete activity.**

Within the sequence of many activities, *NSI* is primarily an Invitation, but students could use these prompts to deepen their observations during the Exploration phase of any activity.

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the natural world. Using *I Notice, I Wonder, It Reminds Me Of* before *NSI* gives students practice making observations and asking questions. Some other BEETLES student activities are focused on making explanations from evidence, and are good follow-ups to *NSI* in which students can continue to develop their ability to make observations, ask questions, and construct explanations from evidence. Such activities include *The Case of the Disappearing Log*, *Bark Beetles Exploration*, *Structures & Behaviors*, and *Tracking*.

Examples of Things to Observe & Ask Questions About

color

size

shape

texture

comparisons
(is it the same everywhere?)

?

Mystery Object

durability
(how hard would it be to break?)

smell

weight

pattern

weird markings

volume

density

Using language of uncertainty

I think...because...

Perhaps...

Possibly...

In my experience...

I wonder if...

Maybe...or...

The evidence seems to show...

Instructor Questions Resource Page

Questions that encourage observations. Use these questions to encourage observations about the physical characteristics of an object or discovery. This helps students get to know the object and gather observations that can be used later as evidence for explanations.

- What do you notice?
- What does it remind you of?
- What can you find out by using your other senses-—smell, touch, etc?
- How heavy/dense is it?
- What can we say about its shape?
- We haven't heard from you, Sarah. Check out the size—what do you see?
- What color is it? Is it the same color everywhere?

Questions that encourage student dialogue. Use these questions to involve all members of the group and to model the importance of multiple perspectives and corroboration in scientific investigation. Questions that ask a student to agree or disagree with another's observations are low-risk and help involve students who may be reluctant to speak. They also encourage student-to-student dialogue.

- Isaiah, do you see the holes, too?
- Do you agree with what Bernice said?
- Does it also seem to be that way from your perspective too?
- What do you think, Juan?

Questions that deepen observations about a specific feature or phenomenon. Use these questions to follow student curiosity about a specific aspect of an object or discovery going beyond general observations. Restating a student's observation before asking another question helps keep the discussion on-track.

- Is there any pattern to what we're observing? If so, is there any place on the object where the pattern does not exist?
- So, Roberto showed us that these holes go all the way through this object. What else can we notice about them? Are they like that everywhere?
- Where have you seen something like this before?
- Is there anything else on the object that could be related to this?

Questions that encourage explanations. Use these types of questions to find out what students are thinking and to encourage them to begin to make explanations based on what they've observed. Make sure students share the evidence behind their explanations.

- What makes you think that?
- How long do you think it has been that way? What's your evidence?
- If it reminds you of an accordion, do we see any evidence it functions like one? Why could that be important?
- Where did this object come from? How long has it been here? How can we tell?
- Has this object been altered by outside forces?
- What could have caused this? Do your observations back up that idea?
- Can anyone else come up with an explanation for what this is or where it came from?

FIELD CARD

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

Nature Scene Investigators*: *NSI

Introducing the Activity

1. There are mysteries everywhere in nature!
2. Explain—if you know how to observe, ask questions & make explanations, nature is exciting and interesting.

▶ *You'll be Nature Scene Investigators checking out a mystery object.*

3. Students form two concentric circles facing inward, with inner circle sitting/kneeling.
4. Explain roles: inner circle makes observations, outer circle asks questions

Making Observations and Asking Questions

1. Unveil the mystery object & set it in the circle.
2. Tell the inner circle to make observations & the outer circle to ask questions.
3. Facilitate this stage of the discussion by encouraging participation, interaction, observations, questions, & conversation.
   - To encourage participation establish non-verbal signals for agreement
   - To encourage interaction, include the outer circle.
   - To encourage observations & questions, use prompts like:

▶ *What do you notice?*

▶ *What colors do you see? Textures?*

▶ *Is it heavy or light?*

▶ *What do you notice with other senses?*

▶ *How would you describe its shape?*

   - To encourage dialogue & discussion, use questions like:

▶ *Isaiah, do you see the holes, too?*

▶ *Do you agree with what Bernice said?*

▶ *Sarah, how would you describe the color?*

▶ *What do you think, Juan?*

4. Before students lose interest in the object, ask circles to switch places.
5. Tell everyone to make observations & ask questions.
6. Facilitate this stage of the discussion by focusing students on one part of the object and helping them build on one another's observations to encourage discussion.
   - To help students focus on one part of the object, follow student excitement & ask "going deeper" questions like:

▶ *We've noticed this pattern of it being light on top and dark on the bottom—is there anywhere on the object it's not like that?*

▶ *Are those colors everywhere, or just in certain areas?*

▶ *What true statements can you say about the cracks?*

   - To help students build on one another's observations, ask questions like:

▶ *Roberto showed us that these holes go all the way through this object. What else can we notice about them? Are all the holes like that?*

▶ *Does anyone want to build on what Carla was saying?*

Making Explanations from Evidence

1. *Well before* students lose interest, invite everyone to make explanations based on evidence.
2. Facilitate this stage of the discussion by following their interests, encouraging good science talk, & asking questions that encourage explanations, promote dialogue, & uncover student thinking.
   - To follow student interests, seek out their excitement, then follow it as they make explanations.
   - To encourage good science talk, ask students to share their evidence &define big words they use.
   - To encourage good science talk, ask students to respectfully agree or disagree with each others ideas, & use "the language of uncertainty." (Hold up "Language of Uncertainty Sentence Starters" to help students form their sentences.)
   - To encourage explanations, ask questions like:

▶ *We've wondered about ____; what's an explanation for it?*

▶ *So Sarah, you said that you saw different colors on different sides of the object. What's your explanation for that?*

▶ *What do you think happened to it? What could have caused this?*

   - To encourage dialogue & uncover student thinking, ask questions like:

▶ *What's your evidence for that?*

▶ *Would anyone like to add to that explanation, or come up with a different explanation?*

▶ *What makes you think that?*

▶ *So, Isaiah thinks something may have eaten it because of these small holes. What do you think of that idea, Juan?*

▶ *So Roberto, you said you think this object fell on the ground at some point because of the damage you observed. Does anyone want to build on what Roberto has said?*

3. Keep the discussion moving & transition when students are ready.
4. *Optional crosscutting concept:* Explain to students that many features we observe in nature are "effects" of one or more causes.

FIELD CARD CONTINUED

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5. *Optional crosscutting concept:* Explain, since we can't always "catch the causes in the act," we can make possible explanations for what might have happened.

Sharing & Evaluating Information From Other Sources

1. Invite students to share what it reminds them of, what they know or have heard, & to name their sources.
2. Encourage students to share how reliable they think their sources are.
3. Ask questions to encourage student sharing, such as:
   - ▶ *What does it remind you of?*
   - ▶ *Where have you seen something like this before?*
   - ▶ *Have you ever heard, seen, or read anything about something like this?*
4. After students have the chance to share their knowledge, share relevant information you know about the object, & include your source(s).

Applying the Skills & Catching "Inquiry Fever"

1. Explain to students that they can use these skills anywhere in nature.
2. Take students to an area rich for exploration & send them to explore and use their skills with others.
3. *Optional Crosscutting Concept:* Encourage them to make explanation about possible causes for things they observe.
4. Offer tools like cups, nets, bug boxes, & hand lenses. Give students time to find & explore interesting stuff.
5. Move between groups and help engage students who may be less focused or don't know what to do. Ask questions such as:
   - ▶ *What do you notice about this?*
   - ▶ *What are some questions you have?*
   - ▶ *What's your explanation for that?*
   - ▶ *What's the evidence for your explanation?*
   - ▶ *What do you think about that explanation?*
   - ▶ *Can you come up with a different explanation?*

Wrapping Up & Making Connections

1. Ask students what it was like to use science inquiry skills in nature.
2. Tell students to keep looking for mysteries in nature & using their tools—during the field experience, & beyond it.
3. *Optional Crosscutting Concept:* Encourage students to make & discuss explanations coming up with possible causes for effects they observe. Tell them this is a useful way for scientists to learn about many parts of the natural world.
   - ▶ *When we find interesting stuff in nature, let's keep trying to figure out what caused it. Scientists think about cause and effect whenever they're trying to figure something out, because it helps them better understand the world.*
4. If your object is commonly found at your site, encourage students to look for other examples, & investigate further.
5. Make connections to your theme and/or concepts.

Write additional notes here:

ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) provides environmental education programs nationally with research-based approaches and tools to continually improve their programs.

www.beetlesproject.org

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