beetles

Science and Teaching for Field Instructors

Student Activity Guide

Spider Investigation

This activity is designed to be a follow-up to the *Spider Exploration* activity, and to be done with students who are excited about and interested in spider webs. It's meant for instructors who want to help their students learn how to conduct a more formal and structured investigation. Students compare quantity of spider webs in two different plant communities. The basic structure of this investigation is pre-planned, but students discuss and plan how to make it a fair test with the least amount of bias as possible. Students also analyze their data, make explanations from their findings, discuss possible inaccuracies of their results, and reflect on science practices and investigation design.

Students will…

- **Experience simple methods of data collection and data comparison.**
- **Use data to make explanations.**
- **Discuss and reflect on the limitations of their investigation, and how it might be improved.**

Timing:
about 70 minutes

Grade Level:
Grades 3-8. Adaptable for younger or older students.

Related Activities
Use *Spider Exploration* first; Use *What Scientists Do* before or as a reflection afterwards. Use *Exploratory Investigation*, for students to design & conduct their own investigations of their own questions.

To ensure a successful experience, review the teaching tips found on page 244 and throughout this guide.

For instructor:
1 portable whiteboard/white board pens
At least eight markers—flagging tape, backpacks, or common objects like pine cones.
1 card for each survey area to label as "1" or "2."
Optional—measuring tape.

For each student:
Student journal or paper and hard surface; pencils

Scout ahead of time to find a wide trail that passes through two different plant communities, preferably in an ecotone where both communities are visible at once, with webs present. You'll need space nearby to circle up with your group.

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE	FEATURED CROSSCUTTING CONCEPT	DISCIPLINARY CORE IDEAS
Planning and Carrying Out Investigations	Patterns	Interdependent Relationships in Ecosystems

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

THE LAWRENCE HALL OF SCIENCE
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Spider Investigation

ACTIVITY OVERVIEW

Spider Investigation	Learning Cycle Stages	Estimated Time
Considering Questions	Invitation	10 minutes
Preparing to Investigate	Concept Invention	15 minutes
Collecting Data	Exploration	20 minutes
Organizing & Analyzing Data	Concept Invention, Application	15 minutes
Reflecting on the Investigation Design	Reflection	10 minutes
TOTAL		about 70 minutes

TEACHING TIPS

Field Card. On page 254 of this guide is a pocket-sized version of this lesson that you can use in the field.

Read the Instructor Support Section. Beginning on page 250, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Consider student needs. It takes high-level thinking and some literacy, experience with, and interest in the subject to complete an investigation. Do *Spider Exploration* first so students are excited about spiders and have practice looking at and thinking about spider webs before they conduct the investigation. It's often best, though, to take a break between the two activities, or to do it later in the week so students don't get burnt out on spiders. Students are also most successful with this activity when they have experience with discussion and with making explanations from evidence. See BEETLES *Encouraging Student Discussion and Productive Talk* resources for more support.

Pursuing other questions. It's valuable for students to get to investigate a question they're excited about. This activity focuses on quantity of spider webs, and generally students tend to find it interesting. If you think your students are ready to design an investigation based on their own questions, use the *Exploratory Investigation* write-up to help them come up with a testable question, then to design and conduct an investigation to answer the question.

Considering Questions

1. *Students Walk & Talk* **or** *Turn & Talk* **about spiders and webs again.** Using *Walk & Talk* or *Turn & Talk*, ask students the following questions to help them think about what they learned while exploring spiders and webs, and specifically, where they found spider webs. If students did the optional web survey during *Spider Exploration*, ask all the questions; if they didn't, ask the first question then skip to the last three.

   - *What did you notice about where we found spider webs?*
   - *Where did we find the most spider webs? The least?*
   - *Why do you think there might be more of [X] kinds of webs in [X] areas?*
   - *Do you think we might find the same number of spider webs in grasslands compared to a bushy area [or whichever 2 plant communities you plan to investigate] Why or why not?*
   - *What kinds of factors might affect where spiders do or don't build webs?*
   - *How might we design a scientific investigation to compare the number of spider webs in [community 1] and [community 2]?*

2. **Tell students they'll compare how many spider webs are in [community 1] and [community 2] through a science investigation.** Tell students there are a lot of different ways they could approach this question, like looking up information on the internet, or just talking about what they think might be true. Instead, the group is going to try to answer the question by using a careful scientific investigation to count webs in each plant community.

3. **Point out how students are thinking about patterns.** Explain that as students discuss why there might be more or less webs in different conditions, or why there might be webs of a certain type in [community 1] and [community 2], they are thinking about patterns: Are there patterns of where spiders build webs and where they don't?

4. Highlight how scientists often do scientific investigations to find patterns. Explain that scientists look for patterns as they learn about natural phenomena, then try to explain reasons for the patterns. Explain that counting webs will help them find out which plant community has more webs. Later, they'll try to explain their results.

Preparing to Investigate

1. **Explain the procedure to students—they'll each count webs in all the marked off areas, then analyze the data.** Tell students you'll mark off areas in two different plant communities and each student will be responsible for counting all the webs in those areas. After all the webs have been counted, the group will look at everyone's data and think about what it means.

   - *I'm going to set out markers at a couple of locations in [community 1] &*

TEACHING TIPS

Take a break. If students have just completed *Spider Exploration*, take a break and do something else active before moving into *Spider Investigation* unless students are REALLY excited to keep counting spiders.

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

Making predictions. Making a prediction about where there might be more or less spider webs can set students up to be more biased in their investigations, as some try to show their prediction to be true, skewing the accuracy of their data. To encourage less bias and more open-mindedness, instead of making predictions about where they'll find more, encourage discussion about what kinds of factors might influence where spiders can build webs to catch different critters, and on how to set up an investigation to answer the question.

TEACHING TIPS

Investigations can be engaging and interesting. While this investigation may seem structured with little space for student input, there are actually opportunities for students to be creatively engaged in the process, and to have fun! The puzzle of setting up the investigation so it is a fair test is an interesting challenge. Counting webs can be exciting and fun (kind of like going on a scavenger hunt), and making explanations based on the results can be an active, engaging process that requires high-level thinking.

[community 2].

▶ *In small groups, you'll rotate through each of these locations, stand at the edge of the trail, and count all the webs you can see between the two markers, from the ground to your eye level, and as far out as your arm can reach.*

▶ *Although you'll be rotating through these locations with a group, you'll be responsible for doing your own counting and recording your own data.*

2. **Explain that scientists try to do fair tests that are accurate and unbiased, and try to think of and address anything that could affect their results.** Remind students that the procedure needs to be specific because the group is trying to approach this question like scientists.

3. **Demonstrate each step of the procedure and ask students to agree on how to make each step as fair a test as possible.** Try to get them interested and excited about making the investigation as fair a test as possible. Say each bullet point, then ask questions in the talking points below. Encourage students to discuss and agree on specifics.

- Scientists try for accuracy when they collect data. They try to be exact and careful.

▶ *What should I count as a web? Should I count every bit of silk I see as a web? When counting, should I lean out as far as I can part of the time, and sometimes not lean at all?*

▶ *What else can we do to count spider webs accurately? Why is that important?*

- Scientists try to be fair, not biased. But it's a natural, human behavior to pay more attention to information that supports what we believe to be true.

▶ *Should I focus and try harder when counting in the area where I think there'll be more webs, and not try as hard where I think there will be fewer webs? How can we avoid being biased while counting webs?*

- Scientists try to be aware of what could affect the accuracy of measurements or data.

▶ *What are things that could make our data inaccurate that we should watch out for?* [Examples could include: accidentally counting webs twice, people or animals going through the study area and destroying webs, weather, and seasonal variations in spider activity.] xxxx

Collecting Data

1. **On a whiteboard, model for students how to prepare their journals.** Tell students that while you're setting up markers at the survey locations, they'll be preparing their journals to record data. Ask them to write the names for the two plant communities you've chosen (eg: "grassland" and "bushy area" on either side of the page, with a line separating the two columns. In each column, students should write"Area 1" and "Area

2," with space for numbers below. Make sure students record the date, location, and weather somewhere on their page.

2. **While students prepare journals, mark off at least two equal survey areas 4-6 feet apart in each plant community.** Set up at least two survey locations in each plant community by placing two markers (backpacks, string, flagging tape, branches...) four to six feet apart on the edge of the trail. Use a card to label each area as "1" or "2." To make space for a large group on a narrow trail, make the markers a little farther apart to make each survey area a little longer. Make sure all the survey locations are the same size, and that the distance between different survey locations is consistent in both plant communities.

3. **Split students into groups based on the number of survey locations, make sure they understand the procedure, and remind them to be accurate and unbiased.** Split students into as many groups as there are survey locations. Remind students to be as accurate and unbiased as possible, and make sure they understand what and how they'll be counting.

4. **Explain that early finishers can observe webs, and think about why there are more in some areas.** Let them know that if they finish counting before it's time to rotate, they can make observations and think about what might cause one area to have more webs than another. They can observe spiderwebs—where they are, where they aren't, what webs have evidence of any prey having been consumed, etc.

5. **Announce when groups should switch, and supervise as groups rotate through each survey location and collect data.** Organize the rotation of groups through and counting webs at each survey location. Make sure all students have enough time to finish counting before announcing when they should rotate. Between each rotation, give students time to record their data in their journals on the page they've already prepared.

Organizing & Analyzing Data

1. **Gather students in a circle, then collect and record data from each student in a stem & leaf display for each plant community.** Make a stem & leaf display (it's easy!) for each plant community on a white board (see illustration and description in margin to the right).

   - Give students time to add up the total number of webs they counted in each survey location in a plant community, then do the same for the other plant community.
   - Ask each student to say their total number for each plant community one at a time, as you record the data in the stem & leaf displays. Ask students to be ready to say their numbers so the process goes quickly.

2. **Use *Think-Pair-Share* to guide students in discussing and interpreting patterns in data.** Show students the group data and make sure students understand how stem & leaf displays organize data. Lead a *Think-Pair-Share* discussion in which students look for trends or patterns in the data. Guide the discussion with the questions below:

TEACHING TIPS

Location. If the plant communities are a little farther away from each other and you need to have the whole group counting in one community at once, consider making the markers a little farther apart so all students can be engaged in counting at the same time. Build the suspense when moving between locations so the students are excited to see if there is a difference in web numbers when they arrive in the second plant community.

date
location
weather

[Plant Community 1]		[Plant Community 2]	
Area 1	Area 2	Area 1	Area 2
student data		*student data*	

Stem & leaf displays are an easy way to view the distribution of lots of data, all at once. To make a stem & leaf display, make two columns. The left column is for the "tens" digits (or the hundreds, if your data goes that high), and the right column is for the "ones" digits. If a student tells you they found 25 webs, you would find the 2 row, and then put a 5 in the right column. 31 would be a 1 in the right column of the 3 row. Here's an example of a data set and its stem plot: [9, 6, 17, 14, 13, 15, 25, 25, 23, 31]

[Plant Community 1]	
Stem	Leaf
0	9, 6
1	7, 4, 3, 5
2	5, 5, 3
3	1

TEACHING TIPS

Avoiding "anchoring." During group discussions or decision-making processes, the "anchoring" effect refers to a human tendency in which people cluster their predictions or ideas around an initial statement or piece of information. If you offer your idea first, or have each student say their ideas out loud, the rest of the group may follow your ideas or that of whichever student speaks first instead of thinking about the problem themselves. Avoid this by giving students time to think and perhaps write down their ideas before sharing them.

See BEETLES *Discussion Routines* for logistics of *Think-Pair-Share.*

Student buy-in to discussion. Remind students that they're discussing ideas based on what THEY observed not something their instructor told them or something they read about. This gives ownership of the information to all the students.

Discussing possible explanations. Refer to the BEETLES *Encouraging Student Discussion and Productive Talk* resources for more support on how to lead a discussion of students' possible explanations.

- *What do you notice about the number of webs in each plant community?*
- *What kind of "answers" can you get from this data about where spider webs are found? (E.g. "There were more webs in the grassland.")*
- *Does any of the data surprise you?*
- *What's some information we can't get from the data we collected?*

3. **Invite students to think about possible causes for patterns they noticed by making explanations based on the evidence.** Summarize what the data suggest about patterns of spider webs in your chosen plant communities, and ask students to come up with possible explanations for the causes of these patterns. *For example: "I think there might be more spiders in the oaks because there are rigid branches that would be sturdy places to build webs." Or, "I saw more flying insects in the oaks than in the grassland. Maybe that's why we found more webs there, especially the vertical webs."*

4. **Ask students to share their explanations and help them build on each others' ideas.** As you lead the discussion, ask follow up questions, repeat or clarify what students say, and ask for different perspectives. See examples of follow-up questions below:

   - *When scientists do investigations like this, they often think about possible explanations for patterns they see in their data. We noticed that there were more webs in the [oak forest] than in the [meadow]. Why do you think that's the case?*
   - *Why do you think there were more [orb] webs in the area with the [bushes] than in the area with the [trees]?*
   - *Is there something about how these webs are built that might influence where they're built?*
   - *Could different kinds of prey living in different areas affect where different kinds of webs are successful? How?*

5. **Ask students to make predictions about spider webs in other plant communities.** Bring up and briefly describe another plant community you have explored together, or a green space from their home (e.g. city parks, their backyards, etc.). Ask them to think about similarities and differences between that community and the two plant communities they explored, and to predict whether there would be more or less spider webs (or more or less horizontal or vertical webs) in those communities than in the two plant communities they investigated. Ask a few students to share their predictions and their reasoning. For example, "I think the park near our school would have a similar number of webs as the oak forest because it has big trees with rigid branches like the oaks where we found a lot of spider webs." Do the same with as many other plant communities as your students are interested in discussing.

Reflecting on the Investigation Design

1. **Point out that in a short period of time, students learned some things about where spiders exist in this ecosystem.** Explain that they could do future investigations to learn about other things in other ecosystems.

2. **Ask students to brainstorm flaws in the investigation, and how it could be done better (like scientists).** Scientists constantly try to notice flaws in investigations, and come up with ways to get more accurate results. Ask students to brainstorm possible flaws in the study they just did, or what they would change if they had a lot more time to do the investigation, in order to get more accurate results.

3. **Explain to students how scientists would do longer, more careful investigations.** Explain that even though the group was able to learn some things about the natural world during their investigation, scientists would need to spend much more time and do more careful studies to gather more accurate data.

4. **Ask students what other information they'd need to strengthen their explanations.** Ask students to discuss what other evidence they'd like to have in order to find out with more certainty if their explanations are accurate. Then ask them how they might get that sort of data.

5. **In a *Walk & Talk* or in their journals, ask students to reflect on their investigations.** Use some of the following questions:

   - *What new questions do you have about spiders? What types of data or information would you need to answer those questions?*
   - *What helped you learn about spiders during the investigation?*
   - *Why is it useful to do a scientific investigation, focusing on making explanations from evidence, making it a fair test, etc.?*
   - *What was it like to try to answer a question through a science investigation?*
   - *What is the value of information scientists get from scientific investigations?*
   - *What are other organisms you might want to study? How could you use what you learned from this activity to study those organisms?*

TEACHING TIPS

Don't skip the reflection. If you need to, move your students before reflecting on the scientific process, but don't skip it. It's as important for students to think and talk about experimental design and scientific processes as it is for them to do it.

Use *What Scientists Do* write-up for reflection. See *What Scientists Do* activity write-up for another reflection that uses a diagram to show students core field science practices, and engages them in discussion about which ones they used during a field experience. It can also be used at the beginning of your field experience, before either of the spider activities.

Use *Exploratory Investigation* write-up for students designing and conducting investigations of their own questions. It's useful for students to participate in an investigation that has been partially set up for them, like *Spider Investigation*, but it's also very useful for them to design and conduct investigations of their own questions. See *Exploratory Investigation* for a student activity in which students focus on how to come up with testable questions, and then conduct investigations of their own design of their own questions.

Instructor Support

Teaching Knowledge

Different Styles of Investigations

Teaching students how to conduct science investigations is not something all outdoor science instructors do. Some focus more on other worthy science practices, like asking questions, constructing explanations and arguing from evidence. For those who are interested in doing science investigations with students, there are different styles of investigations to do, and many possible questions to investigate. Some programs focus on investigations where the question, methods, and data-recording systems are already in place, and students are just responsible for following the procedure and collecting data. Other programs emphasize investigations where students generate their own questions and methods, then perform the investigation. There are different reasons to choose different styles of investigations for your students.

It can be useful for students to take part in a pre-planned investigation so they get a model of what a good investigation looks like. Citizen science-style projects give students the experience of collecting data that will be used in a real scientific study. These investigations tend to not engage students in the challenging process of generating questions or designing an investigation. They also tend to not emphasize thinking about what the data means afterwards, though it is sometimes possible to find larger citizen science data sets, that can be used to contextualize and reflect on the data students gather.

If students come up with their own questions, they tend to be more interested and engaged in the investigation that follows, but students usually need solid support in generating and choosing questions that can be investigated.

Spider Investigation falls somewhere in the middle of this spectrum. Students investigate a pre-selected question, but they're involved in certain aspects of the investigation design. They discuss how to make the investigation a fair test, and then after collecting the data, make meaning from what they observed. In this way, students gain familiarity with these parts of the scientific process. Engaging in more structured investigations like this may help students be more successful and efficient in designing investigations of their own later.

Choose the right investigation for your students at the right time. For example, if you would like to do investigations in which students generate their own questions, it's often helpful to work up to this over time. First students need to learn how to wonder about and become interested in outdoor science mysteries, and to learn observation and questioning skills, like those featured in *I Notice, I Wonder, It Reminds Me Of* and *NSI: Nature Scene Investigators.* It's also useful to give students the opportunity to do more structured investigations, or experience field methods, before they design their own investigations. The BEETLES activity *Exploratory Investigation* guides students through the process of coming up with their own questions and designing their own investigations to answer their questions. Some groups will benefit from doing *Spider Investigation* before doing *Exploratory Investigation*. Don't skip the process of asking students to reflect on the investigation design and what their data means—that's an important aspect of engaging students in the the creative process of the investigation and developing their understanding of science as a process.

The question of comparing the presence of spider webs in two plant communities doesn't need to be the one you focus on with your students. Investigate another question about spider webs if there is an easier one to look into at your site, or follow a juicy question students come up with during *Spider Exploration*. If you choose to have students investigate other questions about spiders, use the write up *Exploratory Investigation* to guide this process.

Common Relevant Misconceptions

Student and Instructor Misconception. There is a single scientific method that scientists follow, so incorporating science into outdoor experiences means following these steps.

More accurate ideas. The "Scientific Method" is often taught in science courses as a simple way to understand the basics of scientific testing. In fact, the Scientific Method represents how scientists usually write up the results of their studies (and how a few investigations are actually done), but it is a grossly oversimplified representation of how scientists conduct investigations. The process of science is exciting, complex, unpredictable, and often iterative. It involves many different people, engaged in different activities, in different sequences.

Field researchers often spend considerable time making careful observations before diving into the process of experimental design and data collection; using an activity like *Spider Exploration* before launching into an investigation can give students a similar literacy with the material that will prepare them to be excited and engaged in data collection and prepared for the process of analyzing and making sense of the information they gather.

Student and Instructor Misconception. Science investigations always begin with a prediction or hypothesis.

More accurate ideas. In the past, many science teachers have made making predictions a standard thing to do at the beginning of every investigation. Making predictions can be useful at times, but when a scientist is trying to be as unbiased as possible, predicting the outcome can work against this goal. In the past, students have also often been required to begin an investigation by writing a hypothesis, but there are many investigations in which scientists don't know enough to write a hypothesis until after they have begun investigating.

Often instructors and students make predictions and call them "hypotheses." A hypothesis is actually more than just a prediction– it includes a description of what you think might happen, which also includes an explanation for why this might occur. Scientists refer to hypotheses as tentative explanations. According to the Framework: "A scientific hypothesis is neither a scientific theory nor a guess; it is a plausible explanation for an observed phenomenon that can predict what will happen in a given situation. A hypothesis is made based on existing theoretical understanding relevant to the situation and often also on a specific model for the system in question." It's no wonder that it can be a challenge to help young students create relevant hypotheses based on their usually brief and limited experience investigating natural phenomena. The NGSS suggests introducing hypothesis in later grades.

TEACHING TIPS

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/

Student Misconception. Conclusive scientific data can be collected in an hour.

More accurate information. Yes, it is valuable for students to plan and undertake a short, focused study. In this process, students learn about scientific practices and gain a better understanding of their surroundings. But gathering publishable scientific information requires specific procedures and is a process that can often take months or years to complete. Anyone can use science practices and procedures to learn more about their surroundings, but academic, publishable science investigations take more time and care than short experiences like this activity. It's not accurate, and undercuts science when instructors tell students their investigations are "just like what scientists do." It's more accurate to tell them that they are using scientific skills, thinking in scientific ways, or conducting investigations that are similar to what scientists do. But for students to appreciate the value of science, it's also important to emphasize the time and rigor scientists apply when doing a scientific investigation with publishable results.

Conceptual Knowledge

Spiders are found in every ecological niche except polar ice caps. To build webs and live successfully, sedentary spiders (those that build webs) **need many attachment points for their webs**, but also **enough open space for the web** structure. The webs also need to be **built in an area through which prey pass**. These needs can be met in a variety of locations in any ecosystem, which leads to the diversity and abundance of spiders almost anywhere. When analyzing data with students, keep these factors in mind and share this information if you think it will further student discussion or understanding.

Estimates of spider density in different plant communities is often varied; arachnologists have estimated that ~30,000 individual spiders live in an acre of Mississippi woodland and that upwards of 2.5 million live in a grassland acre (Missouri Department of Conservation). Other communities support different numbers of spiders.

Connections to the Next Generation Science Standards (NGSS)

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 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, figuring out how the natural world works.

Spider Investigation features the science practice of *Planning and Carrying Out Investigations*, and integrates the crosscutting concept *Patterns.* Students also have the opportunity to build some understanding of disciplinary core ideas related to *Interdependent Relationships in Ecosystems.*

Featured Science and Engineering Practice.

Engaging students in Planning and Carrying Out Investigations. According to the NRC's

Framework for K-12 Science Education, students should take part in a variety of different investigations throughout their educational career—some investigations that are more structured, in which an instructor shares a question that students investigate to reach a certain learning goal, and other investigations that engage students in the process of question development and method design. In *Spider Investigation,* the overall structure is pre-planned. But students take part in some aspects of method design and data collection, then look for patterns in their data and discuss some possible explanations for what they observed. In this activity, and in the course of any investigtion with students, it's critical to ask them to reflect on what they would have done differently in order to make their data more accurate. It's also important to point out to students how the process they went through is different from and similar to the type of investigation scientists might use. This builds their understanding of how to conduct investigations, and helps them to better understand the nature of science as a rigorous, methodical way of learning about the world.

Featured Crosscutting Concepts

Learning science through the lens of Patterns. According to the NRC's A Framework for K–12 Science Education, students should be using patterns to think about their observations and explanations across different disciplines of science (and mathematics!). Patterns can be found everywhere and noticing patterns can lead to interesting questions about how and why they occur. This is an important lens for scientific investigations—and it's often how an investigation of a process or phenomena begins. Once you've identified a pattern, it often leads you into Cause and Effect, because you want to be able to explain what is causing the pattern. In *Spider Investigations*, students conduct investigations to find patterns in where spider webs are found. Once they have identified those patterns, they try to explain what might be causing them. Be sure to point out to students that looking for patterns is something scientists do to lead them to make interesting observations or ask useful questions about organisms. This will help emphasize the idea that pattern recognition is a useful skill in any field.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. The *NGSS* make it clear that students need multiple learning experiences to build their understanding of disciplinary core ideas. *Spider Investigation* gives students an opportunity to develop understanding of some disciplinary core ideas related to LS2.A *Interdependent Relationships in Ecosystems.*

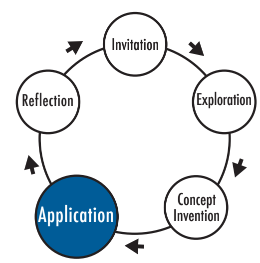
When students observe how many spider webs exist in different locations, and discuss why this might be the case, they build understanding of the idea that organisms are dependent on their environmental interactions with living and nonliving factors, and that organisms survive where their needs are met (LS2.A). Students also build some understanding of the idea that though species vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared (also LS2.A).

You can informally assess student understanding of these concepts during different stages of the activity through individual interactions with students, and by listening carefully during the group discussions. This information can help you decide which

INTERESTING IDEAS

Translating the codes used in the NGSS: Each standard in the *NGSS* is organized as a collection of performance expectations (PE) for a particular science topic. Each PE has a specific code, provided here so that they can be easily referenced in the *NGSS* documents. The first number or initial refers to the grade level: K - kindergarten, 1 - first, 2 - second, etc...MS - middle school, and HS - high school. The next letters in the code refer to the science discipline for the standard: LS, PS, ESS, ETS. The number following the discipline denotes the specific core idea within the discipline that is addressed by the PE, and the last digit identifies the number of the PE itself.

So...3-LS4-4 means it's a third grade standard for life science, addressing the fourth core idea (Biological Evolution: Unity and Diversity) within the life science standards. It's also the fourth PE that makes up the complete LS4 standard at this grade level.



***Spider Investigation* and the Learning Cycle.** This activity brings students through a full learning cycle. Within a sequence of many activities focused on developing understanding of interdependent relationships in ecosystems, or spiders, this activity is an Application.

FIELD CARD

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

Spider Investigation

Considering Questions & Making Predictions

1. *Walk & Talk* or *Turn & Talk*: Think about spiders & webs. (Skip questions 2 and 3 if students did not do the optional web survey in Spider Exploration.)
   - ▶ *What did you notice about where we found spider webs?*
   - ▶ *Where did we find the most webs? The least?*
   - ▶ *Why do you think there might be more of [X] kinds of webs in [X] areas?*
   - ▶ *Do you think we might find the same number of spider webs in grasslands, compared to a bushy area? [substitute 2 plant communities you will investigate]. Why or why not?*
   - ▶ *How might you design a scientific investigation to compare spider webs in [plant community 1] & [plant community 2?]*
2. Tell students they'll compare how many spider webs are in [*plant community 1*] & [*plant community 2*] through a science investigation.
3. Ask students to predict where they'll find the most webs.
   - ▶ *Based on what you know about spiders and the differences between the [two plant communities], do you think there will be more spider webs in [community 1] or [community 2]? Why?*

   Or, alternatively to compare 2 types of webs:

   - ▶ Based on the differences between [community 1] and [community 2], and what you know about spiders, do you think there will be more of [web type 1] or [web type 2] in [community 1]? How about in [community 2]? Why?
4. Point out how students are thinking about cause and effect relationships as they make predictions.
5. Highlight how scientists do investigations to test their ideas about cause and effect relationships.

Preparing to Investigate

1. Explain the procedure to students—they'll each count webs in all the marked off areas, then analyze the data.
   - ▶ *I'm going to set out markers at a couple locations in [community 1] & [community 2].*
   - ▶ *In small groups, you'll rotate through each of these locations, stand at the edge of the trail, and count all the webs you can see between the two markers, from the ground to your eye level, and as far out as your arm can reach.*
   - ▶ *Although you'll be rotating through these locations with a group, you'll be responsible for doing your own counting and recording your own data.*
2. Explain that scientists try to do fair tests that are accurate & unbiased, & try to think about anything that could affect their results.
3. Demonstrate each step of the procedure & ask students to agree on how to make it a fair test.
   - ▶ *Scientists aim for accuracy when they collect data. They try to be exact and careful.*
   - ▶ *What should I count as a web? Should I count every bit of silk I see as a web? When counting, should I lean out as far as I can part of the time, and sometimes not lean at all?*
   - ▶ *What else can we do to count spider webs accurately? Why is that important?*
   - ▶ *Scientists try not to be biased. But it's a natural, human behavior to pay more attention to information that supports what we believe to be true.*
   - ▶ *Should I focus and try harder when counting in the area where I think there'll be more webs, and not try as hard where I think there will be fewer webs so that my prediction is right? How can we avoid being biased while counting webs?*
   - ▶ *Scientists try to be aware of what could affect the accuracy of measurements or data.*
   - ▶ *What are some factors that could affect the data we get?*

Collecting Data

1. Show students how to prepare their journals from a model on your whiteboard.

FIELD CARD

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

[Plant Community 1]	[Plant Community 2]
Area 1 Area 2	Area 1 Area 2

2. While students prepare journals, mark off at least two equal survey location areas 4-6 ft. apart in each plant community.
3. Split students into groups based on the number of survey locations, make sure they understand the procedure, & remind them to try to be accurate & unbiased.
4. Announce when groups should rotate, and supervise as groups rotate through each survey location & collect data.

Organizing and Analyzing Data

1. Gather students and collect and record data in stem & leaf displays.Use *Think-Pair-Share* to guide students in discussing & interpreting patterns in data.
   - *What do you notice about numbers of webs in each plant community?*
   - *What kind of "answers" can you get from this data about where spider webs are found? (E.g.: On average, we counted on average 23 more webs in the grassland.")*
   - *Does any of the data surprise you?*
   - *What's some information we can't get from the data we collected?*
2. Invite students to think about possible causes for results by making explanations based on the evidence.
3. Ask students to share explanations & help students build on each others' ideas.
   - *When scientists do investigations like this, they often think about possible causes for the patterns they see in their data. We noticed that there were more webs in the [oak forest] than in the [meadow]. Why do you think that's the case?*
   - *Why do you think there were more [orb] webs in the area with the [bushes] than in the area with the [trees]?*
   - *Is there something about how these webs are built that might influence where they're built?*
   - *Could different kinds of prey living in different areas affect where different kinds of webs are successful? How?*
4. Ask students to make predictions about spider webs in other plant communities.

Reflecting on the Investigation Design

1. Point out that in a short period of time, students learned some things about where spiders exist in this ecosystem.
2. Ask students to brainstorm flaws in the investigation, and how it could be done better.
3. Explain to students how scientists would do longer, more careful investigations.
4. Ask students to discuss what other information they'd need in order to find out with more certainty if their explanations are accurate.
5. In a *Walk & Talk* or in their journals, prompt students to reflect on their investigations.
   - *What new questions do you have about spiders? What types of data or information would you need to answer those questions?*
   - *What helped you learn about spiders during the investigation?*
   - *Why is it useful to do a scientific investigation, focusing on making explanations from evidence, making it a fair test etc.?*
   - *What was it like to try to answer a question through a science investigation?*
   - *What are other organisms you might want to study? How could you use what you learned from this activity to study those organisms?*

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 environmental education program leaders and their staffs. The goal is to infuse environmental education programs nationally with research-based approaches to science teaching and learning, and to provide them with useful tools to continually improve their programs.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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