

Inquiry Project

Grade Level(s): 3rd - 12th Grade	Length of Lesson: 8 - 9 hours total
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Time Breakdown:

- ~2 hours: Introduction and Project Design (observe, question, hypothesize, design)
- ~4.5 hours: Hike to Collect Data
- ~2 hours: Analyze Data, Conclude, & Share

Materials:

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| <ul style="list-style-type: none"> ● <i>For "Landscape Quilts" Lesson</i> <ul style="list-style-type: none"> ○ Whiteboard ○ Paper ○ Clipboards ○ Pencils or Colored Pencils ● <i>Project Introduction</i> <ul style="list-style-type: none"> ○ Notebook ○ A photo of the 'Science Circle' ○ Sticky Notes ○ Optional: Tools they may use during their research ● <i>Data Collection</i> <ul style="list-style-type: none"> ○ Measuring Tape ○ String & Stakes ○ Soil Chemistry Test Kits ○ Soil Light and pH Indicators | <ul style="list-style-type: none"> ○ Field Guides ○ Anemometers ○ Thermometers ○ Water Chemistry Test Kits ○ Compass ○ GPS Unit ○ Slope Measuring Tool ○ Click Counters ○ DBH Tape ○ Spherical Densiometer ● <i>Data Analysis / Conclusion</i> <ul style="list-style-type: none"> ○ Calculators ○ Colored Pencils ○ Graph Paper ○ Large Poster Paper ○ Laptop with Google Slides (or other presentation software) |
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Learning Outcomes: Upon completion of the lesson, students will be able to...

1. Define and identify the landscape's abiotic, biotic, and cultural components.
2. Demonstrate their understanding of the scientific process by designing and completing a hands-on research project.
3. Observe our natural resources and write scientific questions related to what they are curious about.
4. Collect, organize, and analyze data to better understand the answer to their scientific question.
5. Summarize their project and present the process, data collection, and conclusion with their peers.
6. Justify the conclusions of their project by incorporating established scientific principles.

Vocabulary Words & Definitions:

1. **Abiotic:** a non-living factor in an environment
2. **Biotic:** the living organisms in a community
3. **Cultural:** components of the landscape that are evidence of human culture or present, from the past and present
4. **Landscape:** all the visible features of an area of countryside

Recommended Location / Setup:

Start in an indoor or outdoor classroom setting. Once you progress past the introduction, provide the students with space to explore their landscape and develop their questions. At the end of the lesson, it is best to have the students gathered in an area with a screen for presentations.

Background:

Inquiry-based learning, rather than presenting facts, uses student inquiries, questions, interests, and curiosities to drive learning. This level of student involvement makes the learning more relevant, encouraging students to develop their own agency and critical thinking skills.

- Inquiry allows students to explore what they are interested in and have ownership in their learning.
- When students generate observations and questions, it demonstrates their prior knowledge and allows differentiation. This allows students to move towards understanding within their ability level.

POW! / Attention Grabber:

(Time Length: 1 minute)

Have you ever wanted to learn the answer to a question you had?

How did you go about getting that question answered?

Today, we will begin a scientific process that requires answering a question. Before we do that, however, we must truly understand the landscape surrounding us.

Introduction:

(Time Length: 30 - 45 minutes)

Location: an area with a nice view of the surrounding landscape

Meets Outcome #1

Ask the students if they have noticed patterns on the landscape. Have the students think-pair-share before sharing their answers.

On a whiteboard, write the landscape equation ($L = A + B + C$).

Explain to the students that the landscape surrounding us is made of three main components. Ask the students if they can guess what these components may be (give them a hint that the equations letters are the beginning of the words).

L = Landscape

A = Abiotic

- 'Abiotic' refers to the non-living components of the landscape.
 - What in our landscape is non-living?
 - Dirt, rocks, air, water, temperature, etc.

B = Biotic

- 'Biotic' refers to the living components of the landscape.
 - What in our landscape is living?
 - Plants, trees, bacteria, insects, fish, wildlife, fungus, etc.

C = Cultural

- 'Cultural' refers to the components of the landscape that are evidence of human culture or present, from the past and present.
 - What can you see that is evidence of culture on the landscape?
 - Telephone poles, homes, barns, roads, bridges, crops, mines, etc.

Instruct the students to divide their papers into four spaces.

- They may draw a large plus sign or fold their paper, hamburger and hotdog style.

Ask the students to label the four quadrants with one of the four letters from the landscape equation (L, A, B, C).

- Ask the students to sketch the landscape before them, but they may only draw items that match the component type labeled in each quadrant (abiotic, biotic, or cultural components).
 - For example, a student may draw a landscape filled with abiotic components in the "A" quadrant. They would do the same process for both the "B" and "C" quadrants.
 - For the "L" quadrant, however, they may draw a landscape filled with all three components included in the landscape equation. Abiotic, biotic, and cultural components.

Once the students have completed their Landscape Quilts, encourage them to show their quilts to the class.

- Pair up the students and give them five minutes to observe and learn about each other's quilts.

Discussion Questions

- What was easy about this activity? What was difficult about it?
- Did this activity encourage you to notice parts of our landscape that you never had before?
- What similarities and differences do you see between your quilts?

Ask the students to silently think about why we call our final product a “landscape quilt.”

Share with the students that the quadrant “L” represents the landscape surrounding us. The landscape is made up of many components. These components are patched together to create the area where humans and wildlife live.

- Just like a quilt, the landscape has many patterns as well. After creating your quilt, what patterns do you notice?
 - Cultural components are often placed in certain areas and arranged in certain ways.
 - Trees and vegetation grow on the north-facing slopes of mountains
 - Small bodies of water eventually flow downhill into larger ones
 - Some rocks are exposed, others are not
 - More plants grow near waterways
 - Animals migrate north or south throughout the seasons, travel on the same path each time?

Now that we have closely observed the different parts of our landscape let’s learn how this information can help us create a scientific inquiry project.

Body:

(Time Length: 6-9 hours)

Activity 1: The Science Circle

(Time Length: 6-9 hours)

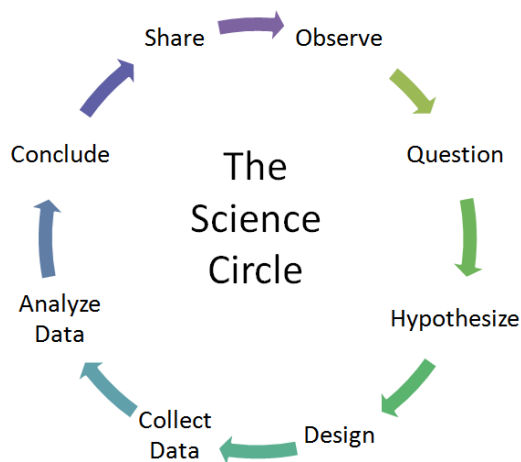
Meets Outcome #2, 3, 4, 5, 6

Location: an indoor or outdoor classroom setting with a flat surface for the students to write on

Note: This lesson will describe the parts of the science circle. The facilitator may choose how they allow students to complete each part of the science circle, depending on their time availability or resources.

Ask the students to observe the drawing or image of the science circle. Ask the students to share what they notice about the circle.

The science circle, or scientific process, is the main method scientists (like those that work at the Wyoming Game and Fish Department) use when asking and answering questions. Using the science circle is a way to ensure you’re looking at as much evidence as possible before making a factual statement.



Let's start the inquiry process by figuring out what questions we may have.

Question

Facilitator Instructions:

- Ask the student to use their observations from the landscape quilt activity to generate questions.
 - Encourage the students to think of as many questions as possible!
- Write down the questions they suggest on a sticky note.
- Organize their sticky notes around similar themes, thinking about the broader phenomena these questions explore.
 - Phenomena are central to next-generation science standards and can be defined as "a fact or situation that is observed to exist or happen, especially one whose cause or explanation is in question."
 - More NGSS resources on phenomena can be found here: <https://www.nextgenscience.org/resources/phenomena>
- Explain to the students that experiments start with asking a question about something that has been observed. Good research questions must be about something that can be measured. They typically begin with how, what, when, who, which, why or where. Here are some exploratory questions to help get students thinking:
 - Form: What is it like?
 - Function: How does it work?
 - Causation: Why is it like this?
 - Change: How is it changing? What was it before? What will it be next?
 - Connection: How is it connected to other things?
 - Patterns: Is there a pattern here? What is behind the pattern?

- If feasible, have students self-organize into groups based on question topics/phenomena. If necessary, some rearrangement of students for balance or resource constraints is fine.
- Once topic groups have been organized, coach students to hone in on their questions to focus on one specific, simple question that can be investigated within the constraints of available research tools and timeframe.

Three types of questions lead to three study designs:

	Descriptive	Comparative	Correlative
Questions	How many, how frequently, and when?	Is there a difference between groups, conditions, times, or locations?	Is there a relationship between the two variables?
Example Questions	• How many ____ are there in a given area? • How frequently does ____ happen in a given period? • What is the (temp, speed, height, density, distance, pH, DO, light density, depth, etc.) of ____? • When does ____ happen during the year? • Where do ____ (animals) travel over time?	• Is there a difference in ____ between group (or condition) A and group B? • Is there a difference in ____ between (or among) different locations? • Is there a difference in ____ between two different times?	• What is the relationship between variable one and variable two? • Does ____ go up when ____ goes down? • How does ____ change as ____ changes?
Study Design	Choose one variable that is measurable or observable	Choose one variable (dependent) that can be measured in at least two different places, times of the year, elevation, etc. (independent variable). *	Choose two variables that can be measured together and tested for a relationship

Note: The independent variable is what you change, and the dependent variable is what changes as a result.

Hypothesize

A hypothesis is an educated guess about the answer to your question. The hypothesis must be measurable and answer the original question you asked.

- For descriptive studies, your hypothesis will be a guess about how many, frequently, when, etc.
- For comparative studies, your hypothesis will predict what will happen to the dependent (responding/measured) variable when the independent variable is changed.
- For correlative studies, the prediction will be about the relationship between the two variables (Are they related? Strongly related? Not related? etc.)

Design

Note: It can be helpful to have the available research tools present for students to view while designing their study.

A study design should include:

- Logical steps to do the investigation
 - Write out the steps so you can give your procedure to another group and they could carry out your investigation without confusion
- Established variable(s) you plan to study
 - What is changed? (manipulated/independent variable)
 - What is measured? (responding/dependent variable)
- Identify how, when and/or where the observations/measurements are taken
 - How will samples or measurements be repeated?
- How is your sampling/measurement method consistent or systematic? (controlled variables)

Important things to consider when designing your study:

- The context (location, time constraints) and other sideboards (equipment available, feasibility of reaching study sites, safety, research group ability)
- Consistency in procedure
- Replication
 - Repeating measurements over time or location and/or repeating individual measurements to ensure accuracy
- Removing selection bias for test sites
 - Set random or specific intervals for locations/elevations/etc. *before* you set out to collect data or have a plan on how you're going to randomize when in the field
- Removing or keeping consistency in as many other variables as possible (other than the ones you are trying to test). Be sure to note any factors you think might impact your study that you are not testing.

- Think about who and how your team will record data
 - Consider the easiest way to compare it when you move on to analysis. This is often in the form of a chart or table but can also include photos of the study site.
 - Be sure to record the location (GPS coordinates), date, time of day, weather, and a description (or photo) of each study site/sample location.

*For additional information on guidelines for developing student data sheets, see Project WILD pg. xxiv.

*For mapping field study sites, see Project WILD pg. xxv.

Collect Data

Suggested Materials can include the following: Measuring tapes, string & stakes (for plots/transects), soil chemistry test kits, soil light/moisture/pH meters, field guides, anemometers, thermometers, water chemistry test kits, compasses, GPS units, inclinometer, click counters, DBH tapes, spherical densiometer, kitchen scale, doyle ruler, Cruz-all, increment borer.

Assist students in implementing their design. Reiterate the important things to consider that were mentioned in the step above.

If you plan to bring students on a hike for data collection, including a safety briefing. Before departing to collect data, cover the following information with participants:

- Wearing proper footwear, such as closed-toed shoes or sturdy hiking boots, is highly recommended.
- Please stay on the trail when possible and maintain your distance from wildlife. If you need to leave the trail to collect data, be careful not to destroy plants.
- Staff/group leaders will carry bear spray. Please stay with the group at all times and if you spot any possibly threatening wildlife, stay calm and inform your group leader.
- Bug spray and sunscreen can be helpful to make your hike a more comfortable experience in the moment and afterward.
- Be sure to pack sufficient water (*at least 2 liters*) and remember to drink that water frequently. Also, do not forget your lunch!
- Staff will be bringing first aid kits with us. Please inform us of any serious allergies to insect stings, bites, or other medical conditions.
- A camera or phone with a camera is helpful to document data sites
- Bring a layer like a sweatshirt or a windbreaker/raincoat in case the weather changes. A hat is nice too.
- Be careful not to drop any trash on the ground, and pack out any you may find.

Analyze Data

Upon returning to camp (or school or other base location) give students time to wash up and regroup before jumping into the analysis portion.

There are three steps to data analysis: Organizing the data, identifying relationships, and interpreting the data.

First, organize the data:

- Organize results into graphs, tables or maps.
- Means, medians, modes, ranges, percentages, t-values, r-values and estimations calculated when appropriate.

Study Type:	Descriptive	Comparative	Correlative
Typical data representations for analysis	• Charts • Line plots • Bar graphs • maps		• Scatter plot • r-values

Then have students ask themselves: (*Identify relationships*)

- What patterns do you notice in the data?
- Might there be any cause-and-effect relationships?
- What discrepancies exist?

Finally, identify relationships in the data and think about how these patterns identified in the data provide evidence for a conclusion/claim. (*Interpret data*)

Conclusions

Make a claim that answers the investigative question. Use evidence from your observations and data collection to support that claim.

- The claim is a one-sentence answer to your original research question
- Your evidence should support the claim and consist of data you collected in the investigation
- Justification/reasoning for your claim connects the evidence to the claim by incorporating established scientific principles

Considerations for when you are writing your claim...

- Does the claim answer the question?
- Does the evidence support the claim?
- Does the reasoning connect the evidence to the claim?

Now that you have completed your experiment and have a conclusion, there are likely still some questions that came up for your group due to the process or things that didn't go the way you expected. Think about the following:

- What questions do you have about the data you collected? Were there any discrepancies? Surprises?
- Compare your data to similar systems or models
- Identify factors in the field that may have affected the outcomes of your data.
- What questions do you have about the way you gathered your data? What would you do differently next time? How could you have made it more systematic?
- What other data or information might we need to collect or find in the future to help support your conclusion(s)?
- How does this data help you to understand the entire system?
- Did you identify any problems that need to be solved?
- Now that you've completed your study, what new questions do you have that would be worth exploring in the future?

Share

The most important part of the scientific process is the last step — Sharing! If you don't share your study and its outcomes with others, it can't further the scientific community's collective understanding. This last step makes the science circle a continuous process (a circle), not just a linear process that ends. When you share about your study, other people may think of additional related questions that they'd like to explore or ask thought-provoking questions about how you carried out your experiment that can lead to additional studies.

Inform the students that they will share their study results with the rest of the students in a "Research Symposium." Ask the students to put together a presentation (either on poster paper or digitally using google slides) that shares their entire research project (all steps of the science circle) with others in an organized and concise manner. You may also want to include the following:

- An introduction to your research team members
- A backstory explaining what led you to your specific research question
- Photos of your data collection process or study sites and details on how you chose them
- Photos of the equipment you used to carry out your research and explanations of how they are used
- Graphs, charts or tables that display your data in an organized format
- Maps of your data collection sites

- What questions do you have about the way you gathered your data? What would you do differently next time? How could you have made it more systematic?
- What other data or information might we need to collect or find in the future to help support your conclusion(s)? Do you have any new questions that you'd like to explore?

Consider planning who will present each portion of your project, and be sure to include all members of your research team. A practice run of your presentation doesn't hurt!

Provide students with time to officially create their science projects.

Conclusion:

(Time Length: 5 minutes)

Location: an indoor or outdoor area, wherever the students presented their projects

Congratulate the students on their accomplishments. Together, we all learned more about our landscapes through the science circle.

Concluding Message / Transition to the following program:

The Wyoming Game and Fish Department personnel, like our biologists, depend on the science circle to better conserve our wildlife.

Resources:

- Project WILD, page xvii: Project WILD Field Investigations
- Project WILD, page 529: Sampling Methods



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