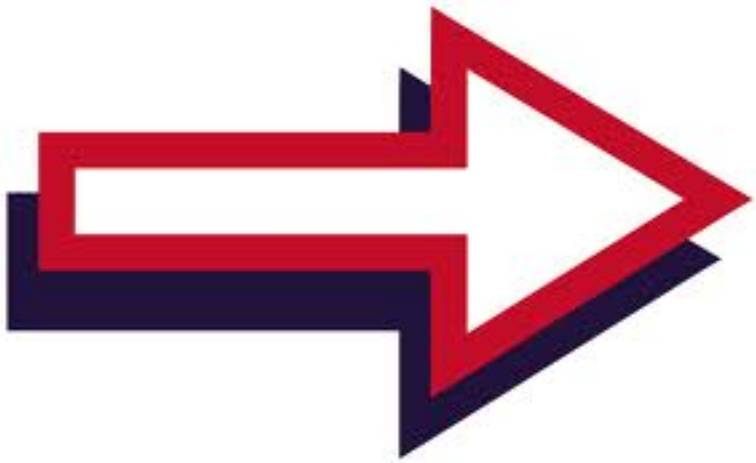
LISELL
Lesson Starters

Explaining Cause and Effect Relationships



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Teacher Background
LISELL Inquiry Practice 3 - Explaining Cause and Effect Relationships

The third LISELL inquiry practice involves *explaining cause and effect relationships*. Cause and effect relationships can be more abstract and complex than they first appear. Particularly for many young adolescents, cause and effect thinking takes time and practice to develop and articulate. It is worth the time to help students develop this skill because it is useful in everyday life as well as in the study of science.

In science, our working definition is that **a cause and effect relationship exists when we know and understand how one event, the cause, brings about another event, the effect, through some mechanism we can explain using scientific knowledge and reasoning.** When students study cause and effect relationships explicitly, they learn to think critically. Practicing cause and effect thinking also helps students to better understand scientific investigations, models, diagrams and processes by learning to identify the actions, events, or conditions (the causes) that lead to or create specific consequences (the effects).

Sometimes people assume that when two events occur together (co-occurrence), then one of the events must have caused the other (causality). Sometimes this is the case -- when we see lightning this is almost always followed by the sound of thunder and so we conclude that the lightning causes the thunder (which, in fact, it does). Sometimes, though, two events may not be linked by a cause and effect relationship -- when the weather gets cold in the fall, people are more likely to get the flu, so we may conclude that cold weather causes the flu. This turns out, however, not to be the case. Research in psychology has shown that most people tend to think this way naturally -- humans are constantly constructing hypotheses about cause and effect relationships to explain our observations of the world around us. These mental models help us to predict and control our environment. We do this even when we don't consciously think about it, probably as a survival mechanism.

By studying scientific theories about the workings of the natural world, learning about processes such as the food chain, the water cycle, erosion, and physical changes, drawing on their growing knowledge of science content, and practicing how to articulate these understandings orally and in writing, students will become better able to explain cause and effect relationships.

We have designed a series of LISELL lesson starters that focus on explaining cause and effect relationships to give all students, but particularly English language learners, brief but regular opportunities to think, talk, and write about these important inquiry practices. The lesson starters present concise scenarios situated in life science, physical science, Earth science, or general science, and depicted in narrative form. Students are asked to draw quick sketches or diagrams and then work together to analyze and talk about what they know about the possible causes for effects they observe in the scenario. In some cases students are provided with "if/then" prompts to guide their development of explanations of cause and effect relationships in the scenarios.

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The Kaibab Deer Population

Kaibab deer live on the Kaibab Plateau in Arizona. The Kaibab ecosystem has a natural carrying **capacity** (the number of organisms that can be supported) of about 30,000 deer. During the early 1900's ranchers brought large numbers of sheep, cattle and horses to the Kaibab and these animals grazed on the same land as the deer. By 1905 the deer population had been **reduced** to 4,000. The U.S. Forest Service **responded** by forcing ranchers to move their sheep and cattle, by outlawing Kaibab deer hunting, and by **promoting** hunting of the local wolves, coyotes and mountain lions that were the natural predators of the Kaibab deer.

By the 1920's the Kaibab deer population had increased to over 60,000, much higher than the carrying capacity of the ecosystem. Many of the deer starved to death. After that, some deer hunting was allowed again, and the populations of the natural predators (wolves, coyotes and mountain lions) were allowed to return to **normal**. Today, the Kaibab deer population on the Kaibab Plateau is **approximately** 15,000.

<u>Sketch your understanding of key things that happened to the Kaibab deer and other animals in Arizona. Then discuss the following two questions with a partner and write your answers:</u>

1) What were the **causes** of the Kaibab deer population getting so high in the 1920's?

2) What was the **effect** of letting wolves, coyotes and mountain lions come back to the plateau in the 1930's?

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Seed Germination

Seeds **contain** a plant embryo (a baby plant) waiting to **emerge**, grow, and develop into an adult plant. Seeds have a hard seed coat for protection and contain food for the plant embryo to **survive** until it can grow leaves and begin to **produce** its own food through photosynthesis. Seeds wait until the environmental **conditions** are right before they begin to germinate, or grow. Seeds germinate when they absorb water, **causing** the hard seed coat to swell and burst. Germination begins with the **appearance** of a root tip, followed by the leaves and stem.

An oak tree drops its acorns (seeds) during a drought. For several months there is no rain. After that, it rains for several days in a row.

<u>Draw a labeled diagram of your understanding of what happens to seeds in the process of germination. Then discuss the following two questions with a partner and write your answers:</u>
1) Describe the **effects** of the drought and rain conditions on the acorns.
2) What **caused** these effects on the acorns?

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Inventing the Superball

Norman Stingley was an industrial chemist who worked in a rubber factory in the 1960s. His job was to use chemistry to make stronger rubber tubes and belts for cars and machines by inventing new **formulas** for synthetic (artificial) rubber. But Norman Stingley also liked balls – he liked balls a lot. He used to bounce a ball while he thought about how to make stronger rubber tubes and belts. One day he had an idea. He could use the machines that compressed the synthetic rubber to make a stronger and bouncier rubber ball. He **reasoned** that if he could **cause** the rubber to be squeezed into a denser ball, the **effect** would be a much higher bounce. He worked in the lab at night and came up with a formula for a ball that could bounce three times higher than a normal rubber ball. He named his new ball the Superball.

He took his invention to Wham-O, the toy company that also made the Frisbee and the Hula Hoop in the 1960s. They thought Norman Stingley's Superball was a great new toy and started **producing** them right away. Superballs can now be found all over the world thanks to Norman Stingley's **cause and effect** thinking and his love of rubber balls.

<u>Sketch your understanding of how Norman Stingley invented the Superball. Then do one of the following activities with a partner:</u>
1) Write a sentence that describes in your own words how Norman Stingley used **cause and effect** thinking to invent the Superball.
2) Write a sentence that describes a new kind of ball that you would like to invent. What would be special about the ball? What would **cause** this special way that your ball functions and what would the **effect** be?

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How Cars Changed Cities

Sometimes a scientific invention can **cause** changes that were not expected. These changes can **affect** the way we live. For example, the invention of the car has changed what cities look like. Cars were invented just a little more than 100 years ago. How were cities **designed** before cars and how are they designed now?

Today, some of the most common things you see in cities are highways passing through the middle, gas stations at every major corner, and traffic lights on every street. These are all **effects** of the number of cars we have. Before cars were invented, homes and businesses needed to be much closer together. One **effect** of cars is that cities have spread out, and suburban **communities** are **located** far from businesses and stores. The effect is that people have to drive when they want to go somewhere. Driving more cars also **causes** us to **import** oil from foreign countries. Effects of importing oil include more **economic** costs, more pollution and different political relationships. Cars give us freedom to go where we want, but they have caused many changes to how we design the places we live.

<u>Sketch your idea of how a city would look if cars disappeared. Then do the following activities with a partner:</u>
1) Write an "If…Then…" statement about how cities would change if cars disappeared.
2) In your "If…Then…" statement, identify the cause and the effect by circling the cause and drawing a rectangle around the effect.

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Your Water Footprint

A water footprint sounds like something that you leave behind after you've been walking through puddles, but it means something very different in **environmental** science. Your water footprint is the amount of water you use both **directly** and **indirectly**. The water that you use every day to drink, cook, shower, wash your clothes and flush the toilet is your direct water footprint. Your indirect water footprint includes the water used to grow or **manufacture** something. This is sometimes called "hidden water use" because we may not know that we are using this water.

For example, to make a cup of coffee actually uses about 37 gallons of water. How is this possible when you only see 12 ounces of liquid in your coffee cup? The rest of the water went into irrigating the coffee plants on the coffee farm and washing, **processing**, roasting, packing, and **transporting** the coffee beans. The average person in the United States has a water footprint of about 500,000 gallons of water per year, more than double the **global** average.

Make a list of all the things mentioned that directly and indirectly make up our water footprints in the United States. Then discuss the following two questions with a partner and write your answers:
1) What are some of the **causes** of people in the United States having a larger water footprint than people in other countries?
2) What are some of the **effects** of people having a large water footprint?

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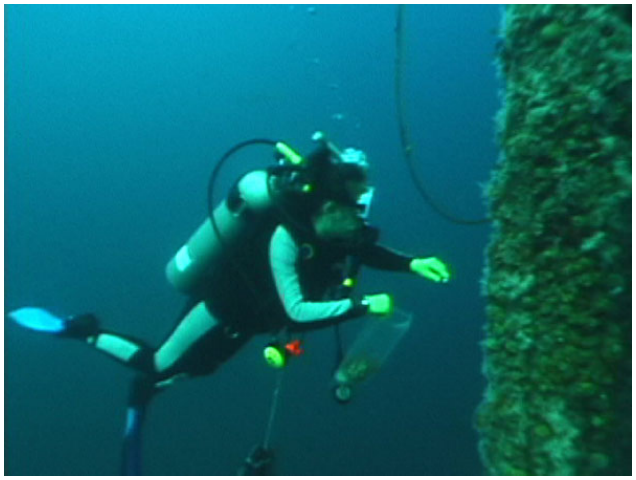
Who are Scientists?



We typically think of scientists as old white men with crazy hair who wear white lab coats and **conduct** experiments with chemicals in laboratories. While some scientists do fit this **description**, most do not. Many scientists are women, and there are scientists of every race, ethnicity and nationality. There are scientists who wear jeans and a t-shirt to work, or a hard hat, or even a wetsuit. Some scientists conduct their **research** in a desert or a wetland or in the ocean. Scientists work in health departments, forests, weather stations, universities, in hospitals, as members of the government, and in many other places. Scientists play important **roles** in local communities. See if your class can invite a local scientist to come and talk about what he or she does and how their work **benefits** your **community**.

With a partner, write your answers to the following two questions:
1) What is the **cause** of many people thinking that most scientists are old men with crazy hair working in a laboratory?
2) What is one **effect** of people believing in this stereotype of scientists?

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Soil Erosion and Runoff

Soil **erosion** is the **process** of soil particles being carried away by water or wind and deposited somewhere else. A common **cause** of erosion is runoff when water does not soak into the ground after it rains. Developed **areas**, with lots of roofs and pavement—such as a school—can increase erosion by **causing** large amounts of water to flow in a short time across small areas of soil. The flowing water then carries the soil away. One good way to **reduce** erosion and runoff is by planting additional plants in areas where erosion and runoff are **occurring**. The roots of plants help the soil to absorb more water and help to hold soil in place, reducing both erosion and runoff.

Imagine that your school builds a new parking lot. Your class notices an increase in erosion around the parking lot. Your principal asks your class for advice about what to do.

Think about what you could do to decrease erosion around the parking lot, talk to a partner, and then write your answers to the two questions:
1) What is **causing** the erosion and runoff around the new parking lot?
2) What would the **effects** be of planting a row of bushes around the new parking lot?

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Acid Rain

Water pollution comes in many forms. Some are easy to see, like an oil spill or trash floating in a lake. Other forms of water pollution are more difficult to **detect**, such as acid rain. Acid rain is rain that has been made acidic by certain pollutants in the air. An acid is a substance that has a low pH. The scale for measuring pH runs from zero (the most acidic) to 14 (the most basic). A substance that has a pH of 7 is not acidic or basic and is called "**neutral**." **Normally**, water has a neutral pH.

Human activities are the main cause of acid rain. Cars, power plants, and factories **release** many different chemicals into the air that change the atmosphere. These pollutants **cause** acid rain. Acid rain can have harmful **effects** on both plants and animals. Most plants, when **exposed** to acid rain, will become weaker and more prone to damage from infections, insects, and cold weather. A decrease in pH can also be deadly to aquatic wildlife, including fish, insects, frogs, plankton, and aquatic plants.

Draw a quick diagram of what you understand about how acid rain is produced and what happens to plants and animals exposed to acid rain. Then discuss the following two questions with a partner and write your answers:

1) What is one suggestion you have for reducing the **causes** of acid rain?
2) How could the **effects** of acid rain affect people in the state of Georgia?

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Native and Non-Native Plants

The plants that you see around your school or neighborhood can be either native (original to the **area**) or non-native (brought from somewhere else). Often plants (and animals) that have been brought from other parts of the world can **cause** problems for native species. For example, *kudzu*, is a type of climbing vine that is native to Japan and southeastern China. Kudzu was first brought from Japan to the United States in 1876 for the Centennial Exposition (100 Year Celebration of the **Founding** of the U. S.) in Philadelphia. People thought it would be a pretty vine to add to gardens. Kudzu spread through the southeastern U.S. and has become an "invasive species" in Georgia, North Carolina and South Carolina, pushing out many native plant species. Kudzu has sometimes been described as "the vine that ate the South."

<u>With a partner, do one of the following activities:</u>
1) Write a sentence that describes in your own words the **cause** and the **effects** of bringing kudzu from Japan to the U.S.
2) Write a sentence that describes a plant that a visiting alien might bring to Earth. What would the **cause** and the **effect** be of this plant starting to grow on Earth?