Lesson 2: Investigating Interactions Between Objects

Overview

Students examine "interactions" between objects and practice making claims with supporting evidence. In the second part of the lesson, students link interactions to energy as they practice identifying the energy sources and the energy receivers in different situations.

Teacher Background

Benchmarks for Science Literacy states: "The most primitive idea is that the energy needed for an event must come from somewhere. That should trigger children's interest in asking, for any situation, where the energy comes from and (later) asking where it goes..." (*American Association for the Advancement of Science* 1993, p. 84).

In this lesson, students examine events or phenomena with respect to energy in a discrete way and using a layered approach. Initially, students are introduced to simple "interactions" and are asked to acknowledge (make a claim) that the objects are interacting with each other. This interaction is attributed to the involvement of energy in general terms. Second, students practice citing specific evidence to support their claim that an "interaction" occurred. Students practice, using a framework, writing claims supported by evidence for single and multi-step interactions.

Some students may question the necessity of taking the time to include these seemingly simplistic initial steps. Is it really necessary to spell out the fact that a book being pushed over by a person's hand qualifies as an "interaction" involving energy? Calling attention to or isolating the event in a discrete way sets up a logical, scaffolded approach that can be readily layered with more sophisticated concepts. Modeling and practicing with students how to write a claim supported by evidence for seemingly more straightforward cases help students apply this skill as they investigate more complex situations.

As students become adept at writing claims supported by evidence, the scaffolding can be removed. Several sample scaffolds are provided in this lesson and so that teachers can select the level of support their students need. For those interested in learning more about helping students develop and write claims and evidence, several resources are available which are described in the introductory section of *Energy for Maine*. If students are skilled at writing claims

supported by evidence, consider modifying the claims writing portion of this lesson, but not the conceptual scaffolding process.

In the second part of the lesson, students add an energy lens to a number of "interactions" as they practice identifying the energy sources and the energy receivers in different situations. The focus shifts to describing where energy comes from and where it goes. Students begin to recognize that energy receivers can become energy sources. Lesson 2 sets the stage for later lessons during which students look for more specific evidence of energy, learn about different forms of energy, investigate energy transfers and transformations, and discover the meaning of energy efficiency and conservation in familiar contexts.

Energy for Maine defines energy as "the ability to change an object in some way." Observing and describing the effects of energy when something is happening and focusing on where energy comes from and where it goes next will further students' developing understanding of energy.

Take some time to become familiar with the "boundaries" of instruction outlined in this lesson and in Lesson 3. The focus of Lesson 2 is on identifying and defending the notion that an "interaction" has occurred and connecting that interaction to energy. Lesson 2 provides students with the opportunity to see different examples of interactions and become familiar with different examples of evidence of energy. As students make claims and provide evidence to support their claims, it is tempting to ask students to label the different forms of energy. While students may make reference to different energy forms as they work through the stations, recognize that this is the focus for Lesson 3. Students will revisit the stations, adding this layer to their developing understanding of energy.

Teachers should be aware that developing evidence-based claims is often difficult for students. Students may construct a claim with little evidence or justification drawn from the data. Students are often confused about which evidence supports a claim and/or may discard evidence that does not appear to support a claim. A framework that clearly shows the components of an evidence-based claim is an effective scaffold for students.

Key Ideas

- Energy is the ability to change an object in some way.
- When objects interact they act on or influence each other to cause an effect; a change.
- Scientists describe interactions between objects by making claims supported by evidence.

- Evidence that an interaction occurred usually includes one or more (observable) changes in one or both of the interacting objects. Examples include changes in motion, sound, temperature, size, shape, illumination, and color or pattern.
- In an interaction there is an energy source and an energy receiver.

Lesson Goals

Students will:

- describe energy as the ability to change an object in some way.
- recognize the influence (mutual or reciprocal action) that objects have upon one another as an "interaction."
- practice making claims based on evidence.
- describe interactions in terms of energy. For example, energy sources and energy receivers can be identified for various interactions.
- recognize that objects can be both an energy receiver and an energy source.

Vocabulary

claim: a testable statement that answers the focus question of an investigation.

energy: the ability to change an object or substance in some way.

energy receiver: the object or substance to which the energy is transferred.

energy source: an object or substance that is the supplier of energy.

evidence: the data collected by the scientist during an investigation.

interaction: the influence (mutual or reciprocal action) that objects have upon one another.

Preparation

- Become familiar with the flow of this lesson as it requires a substantial amount of direct modeling by the teacher. The lesson uses layered approach to build concepts gradually.
- Determine the level of support students will need in recording claims and evidence and mapping energy interactions. Several scaffolds are included in this lesson that can be used as is or modified to meet the needs of students. When thinking about the level of scaffolding students may need, be aware that some students may simply map the "initial" sources and "end" receivers while other students may extend their thinking to include intermediary sources and receivers. Examine the handouts and

consider making all available to the students. Remember frameworks are guides and students should use them as guides and not become overly concerned about "filling them in" as they would a worksheet. Encourage students to map the information in a way that is complete with the claim, evidence, source, and receiver information and that makes sense to them.

- Practice the demonstrations and using the frameworks to record findings. Copy and cut out a paper spiral using Teacher Resource 2.4: Paper Spiral Template.
- Become familiar with the interaction stations. Select and prepare an adequate number and variety of stations to accommodate the class. Suggestions for alternative or substitute stations can be found in Teacher Resource 2.2. Consider the number of station sets that will need to be prepared to accommodate students. Minimally, prepare duplicate station sets (two sets of directions and two sets of materials) to maximize class time.
- Organize interaction stations sets for easy distribution. Place necessary items on trays or in bins along with sturdy copies of the station directions (pasted on file folders or copied on card stock) and an additional copy of the framework(s). Consider the best location for stations that need safe access to sunlight or electricity, water, etc.
- Two of the stations, Stations 5 and 8, require access to bright sunlight. If sunlight is not available, a lamp with a full spectrum bulb can be used.
- Station 7 involves the use of an electric cup warmer. Place this station in an area where students will not accidently spill warm water. Have several metal spoons on hand (perhaps even "chilling" in ice water) so that students can readily detect temperature changes in the spoon.
- In Station 12, students will be exploring "waves" in a pan of water.

Safety

Make certain that a safe source of heat (ex: a lamp and not an open flame) is used when demonstrating the paper spiral. Be certain to hold or hang the spiral several inches away from the heat source to prevent catching the paper on fire. Teachers and students should wear safety goggles when using the poppers. If using a sound tube in Station 6, provide ample space for students to swing tube without hitting others. Hot tap water is sufficient for Station 7. Make certain that the water temperature remains below 120°F (49°C) to prevent students from getting burned. Keep the water warm by placing the heat safe ceramic mug on a cup warmer.

Materials

Item	Quantity
For opening demonstration: • Text book • Pinwheel • Paper spiral suspended by a piece of thread or string • Lamp with 100 watt incandescent light bulb or other safe heat source	1 set
For student practice: • Wind up car with visible gears • Poppers • Safety goggles	1 per student or pair of students
Scientist's Notebook	1 per student
Teacher Resource 2.1: Writing Claims and Evidence Framework	1 for teacher
Student Handout 2.1: Mapping Energy Sources and Energy Receivers	1 per student
Teacher Resource 1.1: Descriptions of Energy Connections for Suggested Items in Energy Discovery Box	1 as reference for teacher
Student Handout 2.2: Mapping Multiple Energy Sources and Energy Receivers	1 per student
Student Handout 2.3: Scientists' Meeting Minutes – Reflection and Discussion of Interaction Stations	1 per group
Teacher Resource 2.2 Interaction Station Directions	2 identical sets or multiple sets required to accommodate class size.
Teacher Resource 2.3: Interaction Station Teacher Notes	1 for teacher
Teacher Resource 2.4: Paper Spiral Template	1 for teacher
For Interaction Stations: 1. **Hands:** no materials required 2. **Plastic Shopping Bag:** plastic shopping bag, small bits of paper (paper from hole punches work well), desk top 3. **Paddle Ball:** paddle ball toy 4. **Electric Circuit:** D cell, wires, incandescent light bulb, component holders, if available 5. **Solar Powered Propeller:** access to sunlight or lamp with full spectrum light bulb, solar panel, motor. 6. **Noise Maker:** disposable paper noise makers (1 per student) or sound tube 7. **In Hot Water:** access to "hot" tap water, ceramic mug, several metal spoons (Note: A spoon made of silver will conduct heat much more noticeably), electric cup warmer (optional), ice water (optional) 8. **Beads:** access to sunlight or lamp with full spectrum light bulb, UV beads strung as a bracelet or keychain, towel 9. **Spinning Top:** top, box lid or tray to contain top 10. **Yo-Yo:** yo-yo 11. **Pop Up Toy:** pop up toy 12. **Waves:** a dish pan or 9" x 13" baking tray ½ filled with water, small float tub toy (boat), towel	

Time Required: 3 sessions

Session 1: Introduce interactions, practice writing claims and evidence for demonstrations with book, paper spiral, popper, and wind up car

Session 2: Introduce and practice mapping energy sources and receivers, begin interaction stations

Session 3: complete interaction stations, debrief

Connection to *Maine Learning Results: Parameters for Essential Instruction (MLR), Benchmarks for Science Literacy (BSL), and National Science Education Standards (NSES)*

- Describe several different types of energy forms including heat energy, chemical energy, and mechanical energy. MLR D3 (6-8) h
- Present a brief scientific explanation orally or in writing that includes a claim and the evidence and reasoning that supports the claim. BSL 12D/M6** (6-8)
- Notice and criticize the reasoning in arguments in which the claims are not consistent with the evidence given. BSL 12E/M5b* (6-8)
- Energy is a property of many substances and is associated with heat, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. NSES B (5-8)

Teaching The Lesson

Engage

1 Demonstrate an "interaction" between objects.

Select an interaction that is straightforward such as pushing over a book that is standing upright like a domino. Demonstrate the interaction and direct students to observe what happens.

Discuss with students the following:

- *How do we know that the book and hand interacted (influenced each other)?* We know because we observed something happening; there was a change.
- *How could we describe what we observed?* Accept students' ideas. Help students recognize that when two objects "interact" they act upon or influence each other in some way, causing a change – one object does something to another. This change is usually something observable. For example, students might say that we saw the book fall and we heard the book hit the table.

Explore

2 Model how to describe an interaction using a claims and evidence framework.

Use the following example to show how scientists describe interactions:

Scientists describe an interaction by first making a claim that an interaction has occurred and then by looking for evidence that supports their claim. For example, consider what happens when a pinwheel is held outside on a windy day or a person blows air toward the pinwheel.

Write the sentence frame on the board or chart paper or use an overhead transparency of Teacher Resource 2.1: Writing Claims and Evidence Framework to model writing a claim with supporting evidence for this example:

(Say) *A scientist would state the following claim:*
(Write) Claim: The wind (or moving air) interacts with the pinwheel.

(Say) *A scientist would support this claim by providing the following evidence:*
(Write) Evidence: When a pinwheel is held outside (or in the pathway of moving air), there is a change in the motion and sound of the pinwheel.

Point out to students that they should provide multiple pieces of evidence whenever possible to support their claim. Providing more than one piece of relevant evidence substantiates claims more convincingly. Alert students to the fact that finding evidence of energy is challenging in some instances.

Demonstrate a second interaction and how to write a claim based on evidence using the framework. Hold or fasten a paper spiral, suspended by a piece of thread, a safe distance over a lamp (used here as a source of heat). Turn on the lamp. Ask students to observe what happens.

(Say) *A scientist would state the following claim:*
(Write) Claim: The (movement of) warm air interacts with the paper spiral.

> **Note:** *Students may say "heat." The teacher, using students' prior experiences as a guide, should clarify that the heat from the lamp warms the air above the lamp, and the heated air moves up. This rising air causes the spiral to move. "Heat" does not rise but rather warm air does.*

(Say) *A scientist would support this claim by providing the following evidence:*
(Write) Evidence: When the paper spiral is suspended over a heat source (lamp with incandescent light bulb) there is a change in the motion of the spiral.

Revisit the opening book and hand demonstration and model using the framework to review how to write a claim with supporting evidence for this interaction.

3 Support student practice of writing claims and evidence for single and multi-step interactions.

Distribute to each student pair a Wind Up Car. Either provide students with a copy of the Writing Claims and Evidence framework to paste into their notebooks or ask students to make a copy of the framework as a reference. Model for students how to use the Wind Up Car.

Ask students to describe the following in their notebooks:

- *What was the interaction?*
- *Write a claim with supporting evidence about the Wind Up Car.* Support students as necessary in writing a claim similar to the following:

  Claim: The twisted spring interacts with the car's gears connected to its wheels.

  Evidence:
  1. After the twisted spring is released, the car's gears turn.
  2. The car goes forward.
  3. The car makes a sound.

In the second practice example, students will investigate a sequence of interactions.

Note: *Students and teachers should wear protective safety goggles when working with poppers.*

Show students how to turn the popper inside out and place it on a hard surface (table or floor). Ask students to make observations and write a claim supported by evidence.

As before, assist students in using the framework to make a claim that an interaction has occurred supported by evidence. Sample responses are included below:

Claim: A person's hand interacts with the popper.
Evidence: The popper changes shape (it is turned inside out).

Claim: The popper interacts with the surface it "pops" on.
Evidence: The popper changes shape and the popper moves ("pops" up).

Claim: The popper interacts with the surface it falls on after popping.
Evidence: The popper bounces on the table.

Note: *The sequence of events is simplified in these last two steps – elastic energy "flips" the popper. Poppers "pop" regardless of what surface they are on but different surfaces provide different amounts of energy and therefore results. Gravity also comes into play as the popper falls. Students are introduced to different forms of energy in Lesson 3. If poppers are difficult to obtain, superballs may be substituted in this example. If using superballs consider showing a slow-motion video of a basketball or racquetball bouncing, as found in the following collection from Colorado State University* ***http://www.engr.colostate.edu/~dga/high_speed_video****.*

4 Clarify definition of energy and describe interactions in terms of energy.

Revisit students' initial ideas about energy from Lesson 1. Reaffirm, as indicated in the variety of ideas they generated about energy, that there are many different pieces to the energy picture. Explain that in this series of lessons, we'll think of energy as the ability to change an object in some way. Write this definition of energy on the board and consider having students write this in their scientists' notebooks as a reference. Clarify for students any questions they have about defining energy in this way.

Explain to students that scientists often talk about the interactions they observe or measure in terms of energy. Invite students to consider the interactions they've observed and the claims they've written and provided evidence for thus far.

> Discuss with students: *How were the objects in the previous examples changed?* For example, were objects changed by moving them? By heating them? By something else? The "change" is the evidence that energy is involved.

Explain to students that scientists often identify in their interaction descriptions which object provides energy and which object receives energy. By describing interactions in this way- where energy comes from and where it goes - scientists are able to analyze and explain phenomena in terms of energy.

Using the interactions previously introduced and overhead copies of Student Handouts 2.1 and 2.2 Mapping Energy Sources and Energy Receivers, model how to use the framework to map the energy sources and receivers. Provide each student with a copy of each of the frameworks or have students make copies in their scientists' notebooks.

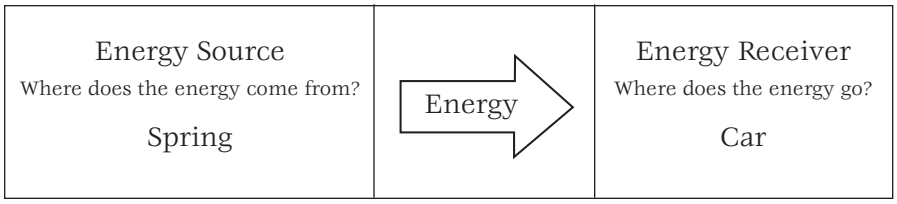
Book-hand example:

Energy Source Where does the energy come from?		Energy Receiver Where does the energy go?
Hand	Energy →	Book

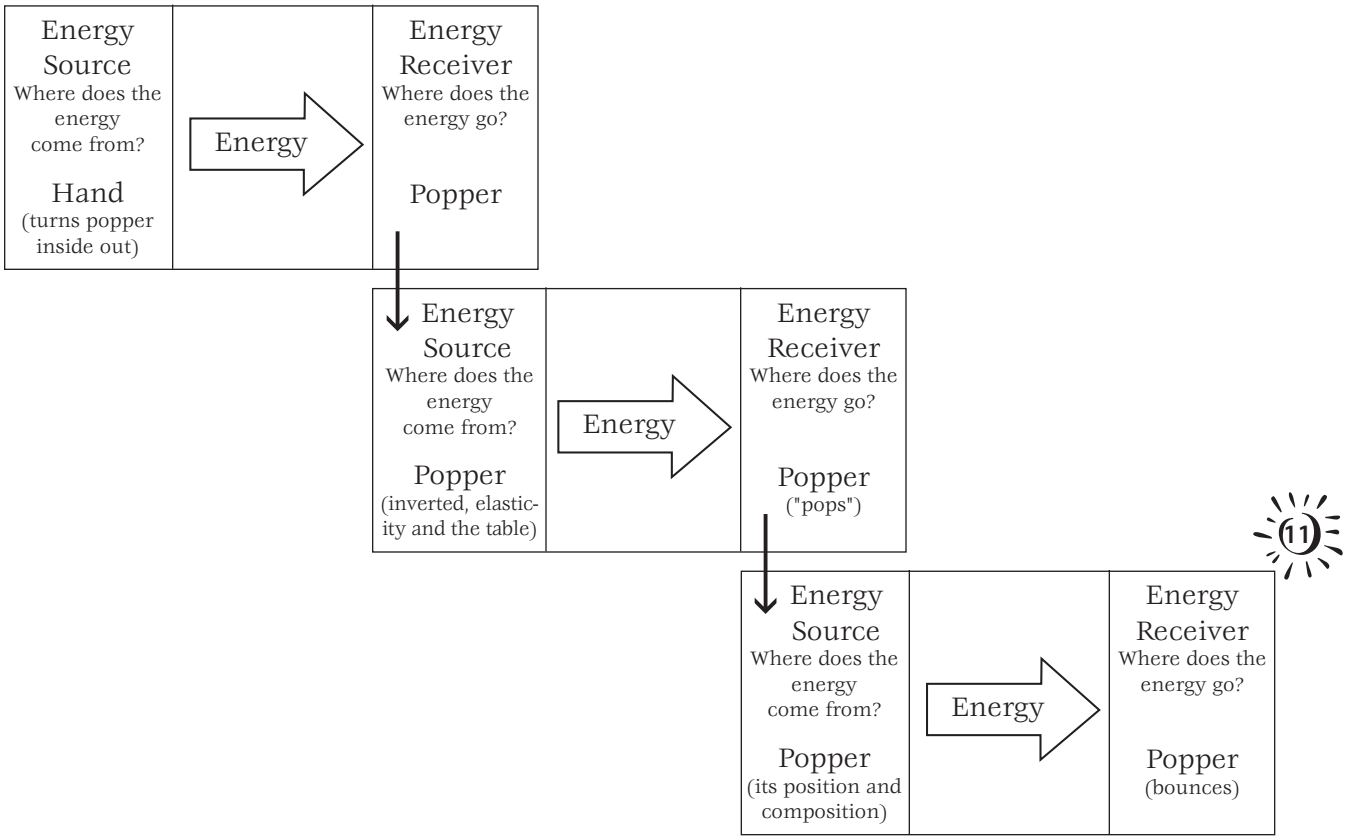
Light bulb-paper spiral example:

Energy Source Where does the energy come from?		Energy Receiver Where does the energy go?
Light bulb	Energy →	Air (moves the paper spiral)

Wind up car example:



Popper example:



*Students should notice that something can be both an "energy receiver" and an "energy source." Discuss this idea with students by posing the question: *Can something be both an energy receiver and an energy source?*

5 Introduce Interaction Stations.

Explain to students they will be describing and mapping interactions for a variety of energy interactions in their scientists' notebooks. Students may use copies of the framework outlined in Student Handouts 2.1 and/or 2.2 or they may develop their own strategy for mapping the energy introduced earlier.

Do one of the stations together with the class. Model how students

will move through the stations, use the framework to make an energy description and mapping each interaction with the energy source(s) and receiver(s), and write a claim supported by evidence. Explain that they will follow this procedure for each station.

Students may work in pairs or individually. Point out that each of the interaction stations has a set of directions that explains what to do. Make certain students are aware of the safety precautions. Instruct students to leave the materials as they found them and ready for the next person/pair when they are finished at each station. Consider setting a 5 minute time limit for students to visit a station. This will help keep students focused on the work of observing and mapping interactions.

As students work, circulate among groups. Support students as needed, ask probing questions, listen to students' ideas, and make notes of students' thoughts and comments.

Reflect and Discuss 

6 Discuss interactions.

Once students have had the opportunity to visit each of the interaction stations, have them form discussion groups of four. Provide each group with a copy of Student Handout 2.3: Prompts for Group Discussion of Energy Interactions. Review the instructions listed on the handout with students. Encourage groups to start their work by allowing individuals to first review the claims, evidence, and maps of the stations and then segue into the group discussion.

Circulate among groups as they work, listening to students' conversations and jotting down notes about their collective thinking. This strategy is helpful in identifying in advance any disputed or misunderstood stations/ideas. Be prepared to redirect students or clarify ideas in a manner (for example, through questioning) that is appropriate at this stage of the lesson.

After groups have reached a consensus on the discussion prompts have each group make their thoughts visible by putting them on a piece of chart paper. Post each group's chart paper. Call students together for a scientists' meeting. Use the groups' charts and the notes collected while students were working to summarize ideas and bring the lesson to a close.

Explain to students that they will have the opportunity in the next lesson to review certain aspects of the stations once more using another energy "lens" introduced in the next lesson.

Extensions

Students may:

- bring in toys or other simple devices from home. Have students observe the interactions that take place and identify energy sources and energy receivers.

Connection to Maine Agencies

A Maine Energy Education Program (MEEP) representative will come to interested schools, free of charge, to guide and support the concepts in this lesson. For more information go to the MEEP website: http://www.meepnews.org/classroomactivities.

For schools in Aroostook County, a Maine Public Service (MPS) representative will come to interested schools, free of charge, to guide and support concepts developed in this lesson. A description of programs is available at www.mainepublicservice.com. Click on the education section of the site. To schedule a presentation contact, Nancy Chandler at 207.760.2556 or nchandler@mainepublicservice.com.

Online References and Resources

Chicago Science Group. (2007). *Science Companion.* Energy. Lesson 3: Energy Transfers: How Energy Makes Things Happen. USA: Chicago Science Group and Pearson Education, Inc. www.sciencecompanion.com