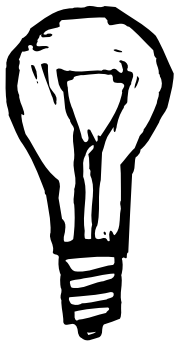

Energy Ideas

Gaining Understanding of Students' Thoughts about Energy

Objectives

Students will be able to:

- express and analyze ideas about energy
- discriminate among scientific and common definitions of energy

Rationale

Energy education is often equated with activities that involve young students in measuring their energy use or conducting energy audits. While students may enjoy monitoring their school or home to find cases where energy is being used unnecessarily, it is important that students understand the reasons for these monitoring activities. Without proper understanding of energy resources, energy degradations, and energy conservation, students might consider the activity simply a game and not see the reason to continue these actions after the lesson is completed.

What should elementary school teachers do when trying to teach students about energy? Although it is unrealistic to expect young children to grasp complex and abstract conceptions of energy, they can begin to investigate various definitions of energy and analyze what energy means to them. If they share these thoughts and ideas with their teachers, lessons can be designed to strengthen correct understandings of energy and to help children recognize limitations in incorrect definitions. The following strategy is one approach to help elicit students' thoughts about energy and give them the opportunity to analyze their ideas.

Introduction

You sure have a lot of energy!

Energy is getting expensive!

I think my battery has run out of energy.

It will take a lot of energy to move that rock.

These are all common uses of the term energy, but in strict scientific terms they are not exactly correct (see **True or False** for explanations of why some common uses of the term energy are scientifically incorrect). Given that the word is used so often and in so many different ways, it is no wonder that students may have misconceptions about what energy is. Secondary science teachers sometimes struggle with trying to get students to overcome misunderstandings of energy.

Elementary teachers can help prepare students to appreciate what energy is by encouraging them to become aware of the presence of energy in their lives. By participating in activities in the *KEEP Activity Guide* and this supplement, students receive a well-rounded introduction to basic energy concepts and begin to appreciate the energy in their lives.

To better prepare students for their energy education, it would be helpful for teachers to know students' current thoughts and ideas about energy. This activity suggests a procedure for providing students with the opportunity to share their ideas about energy and explore how they apply energy to various aspects of their lives and within science class. While listening to students explain phenomena they observe, teachers can assess if and how students use energy and energy-related terms.

Introduction (Continued)

It might be too early to introduce abstract concepts such as energy conservation, but it will be helpful to teachers to know if students equate energy with terms such as effort, force, motion, or fuel. Subsequent lessons could further help students distinguish between these terms and understand how they are used in science. These lessons would help students construct foundational knowledge about energy that would support more scientific energy conceptions later in their learning career.

Below is a brief overview of some basic energy concepts. Additional explanations of energy are found throughout the activities and the **KEEP Adaptations** in this supplement, and in the *KEEP Activity Guide.*

Energy Basics

A common definition of energy is the ability to do work (or to organize or change matter). Work involves force and motion. You can see evidence of energy when something moves or changes (when work is done). Light, thermal energy, and sound are other ways we can detect energy. People might think of energy as a substance such as fuel or a force or power, but in scientific terms energy is a state or condition that can be quantified and measured.

Scientists use energy to describe certain properties of an object or a series of objects. It is similar to how you can describe an object's weight or size, and you can assign a value to quantify an object's energy.

Energy is transferred from one object to another during work (when there is movement or change). The amount of energy that is present before and after work is the same (scientists say energy is conserved). For example, let's say you drop a ball. Scientists can measure the energy before, during, and after the fall. The amount of energy remains constant throughout the process—it is just in different states. Likewise, when an object is thrown, a spring released, or something burned, the energy can be measured and will remain constant. This is the reason behind the statement, "Energy can neither be created nor destroyed, it can only be converted from one form to another." Scientists have found that the amount of energy in a closed system remains constant.

Wherever you look, you can see examples of energy transfers. When you turn on a light, you see the result of energy being transferred from the sun to the plants to the coal to electricity and finally to the light you see. During each of these transfers, energy changes form. There are two main forms of energy—kinetic energy (motion) and potential energy (position). To further classify energy, these forms are sometimes described as thermal (heat), elastic, electromagnetic (light, electrical, magnetic), gravitational, chemical (food), and nuclear energy. See the *KEEP Activity Guide* for more information on kinetic and potential energy.

During energy transfers, it might seem that energy does go away or become reduced. For example, a bouncing ball stops bouncing, a battery dies, or a car runs out of fuel. The energy still exists but it has become so spread out that it is essentially unavailable. Burning a piece of wood releases light and thermal energy (commonly called heat). The light and heat become dispersed and less useful. Another way to describe this process is to say the energy is concentrated in the wood (chemical energy) and becomes less concentrated in the forms of thermal and light energy.

Energy has often been called the currency of life. It flows through Earth's processes, creating wind, providing light, and enabling plants to create food from water and air (carbon dioxide). Humans have tapped into this flow to generate electricity, fuel our cars, and heat our homes. The sun provides Earth with most of its energy. It is important for students to recognize and appreciate this source of energy and to explore the transformations that bring the sun's light into their home in the form of light, heat, food, and fuel. We are fortunate to have many "concentrated" sources of energy. Besides the sun, there is chemical energy found in fossil fuels such as coal and oil and in nuclear resources.

While the amount of energy in our world remains constant, as we use it (transfer it to one form to another), it becomes spread out and less useful. Energy also gives us the ability to work. Through education and becoming aware of what energy is and how we use it, we can learn (i.e., work) to use our concentrated resources more wisely and ensure that they will be available for future generations.

True or False?

- **Energy is found only in living objects.**
- **Energy is a force.**
- **Energy is associated only with movement.**
- **Energy causes things to happen.**
- **Energy is stored within objects.**
- **Energy is a fuel.**
- **Energy is a substance or fluid.**
- **Energy is a product of an activity.**

In strict scientific views, all these statements are false. Following are explanations of why these energy descriptions are "wrong":

- **Energy is found only in living objects.**

This statement is not correct because everything has energy. The composition of an object or its placement determines what kind of energy it has (e.g., chemical, thermal, gravitational). Living things are unique in that they have the natural capacity to convert energy to another form from the food they consume.

- **Energy is a force.**

A force is a push or a pull. Energy is needed to create the force, but it is not the force. A force, through movement, changes the state of energy in an object (e.g., from potential to kinetic energy).

- **Energy is associated only with movement.**

Nonmoving objects have potential energy (sometimes called stored energy).

- **Energy causes things to happen.**

It is acceptable to say energy is needed to lift an object or move things, but other conditions (such as force) are needed as well.

- **Energy is stored within objects.**

This statement might lead to the understanding that energy is a substance (see below). There is potential energy in the chemical bonds of objects or because of its position (e.g., gravity), but the object itself does not contain energy.

- **Energy is a fuel.**

Fuel is a source of energy, but the fuel itself is not energy. Fuel is a resource, such as oil, coal, or foods that we eat. Fuel sources have potential energy in the chemical bonds that make up the substance.

- **Energy is a substance or fluid.**

Energy is a state; it is not matter (i.e., it does not contain molecules). For example, steam, liquid water, and ice are all the same substance (contain the same molecular structure), but because of their different states of energy, they appear different.

- **Energy is a product of an activity.**

Energy is transferred as result of an activity such as electricity generation or eating food. Energy is not created.

Procedure

Designate a bulletin board or a section of your classroom wall to post "Energy Ideas." Here students write sentences that depict what they think energy is. Students can generate ideas in one classroom lesson or you might want to give them a week to post ideas as they think of them. Make sure students know that any idea is a good one; for now they are to generate as many ideas as possible. NOTE: have preliterate students draw pictures and dictate their thoughts to be transcribed.

After students have posted a number of ideas, give students a chance to read through or look at all the ideas. See if students think any ideas are similar and should be grouped together. Try to narrow the number of ideas to five or less.

Have students generate a one-sentence description for each idea. Ask students to examine each idea to be sure it makes sense to them.

Option: You might want to narrow the ideas down even further. Have students decide whether they agree or disagree that each idea defines energy. Encourage students to express the reasoning behind their opinion. This discussion could continue over several days or weeks, supplemented by activities to explore each idea. Over time, students might change their opinions or generate new ideas. Some of the ideas will be more scientifically accurate than others. Challenge students to categorize their thoughts about energy into "scientific" explanations compared to common everyday expressions.

Option: Invite a physical science teacher in to examine the ideas. She or he might identify true meanings behind some of the ideas. For example, the sentence: "It takes a lot of energy to move a boulder" would be more correctly stated, "It takes a lot of work to move a boulder." The teacher might also be able to identify supplementary activities to help students examine their ideas more extensively.

Divide the class into groups of three or four. Have each group design a poster or a skit to portray their understanding of energy. You might want to work with the art teacher to identify creative ways for students to illustrate their posters.

Assessment

- During the activity, observe student contribution and analysis of ideas.
- Examine students' posters to see if they reflect the ideas generated during class.
- Ask students to provide a definition of energy and notice if they provide a rationale for their description.