Walch Science Literacy Series
Biology

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Contents

(R) denotes reproducible activity

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To the Teacher

As teachers, what do any of us want for students? In addition to wishing them healthy and fruitful lives, we want them to be able to think. We want them to be literate in the fields we teach year after year. We want them to develop the thinking skills that will allow them to be respected and productive. We hope they will be critical of false claims and weak arguments. We urge them to study so that they may possess that special body of knowledge that will help them to do their jobs better. In addition, we want them to develop habits of mind that characterize good thinkers. In this program we have developed a tool that will help you direct your efforts to a very worthwhile end, namely teaching science literacy.

What Is Science Literacy?

Project 2061, sponsored by the American Association for the Advancement of Science (AAAS), seeks to promote literacy in science in order to help people live interesting, responsible, and productive lives in a society in which science, mathematics, and technology are central.

In their book Science for All Americans, Project 2061 defined science literacy as "what every high school graduate should understand about science, mathematics, and technology." It recommended that scientific literacy include:

- Being familiar with the natural world and recognizing both its diversity and its unity.
- Understanding key concepts and principles of science.
- Being aware of some of the important ways in which science, mathematics, and technology depend on each other.
- Knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations.
- Having a capacity for scientific ways of thinking.
- Using scientific knowledge and ways of thinking for individual and social purposes.

What Are Habits of Mind?

Science literacy requires understandings and habits of mind that allow people to grasp what science and technology are about, to make some sense of how the natural and designed worlds work, to think critically and independently, and to recognize and weigh alternative explanations of events.

Habits of mind refer to thinking skills, values, and attitudes that, taken together, relate directly to a person's outlook on knowledge and ways of thinking and acting. Habits of mind need to be learned in the context of all scientific content areas. Students need not only to acquire these skills, but also to be able to use them in new situations, both in and out of school.

Habits of mind include values and attitudes, computation and estimation skills, manipulation and observation skills, communication skills, and critical response skills.

The Walch Science Literacy Series uses a variety of content areas to help students develop the necessary habits of mind needed by a scientifically literate person. The following list of habits of mind describes the science literacy skills included in the series.

Values and Attitudes

- Raise questions and seek answers.
- Make hypotheses.
- Make careful observations.
- Keep honest, clear, accurate records.
- Offer reasons for findings.
- Understand that different explanations can be offered and that it isn't always possible to tell which is correct.
- Value and exhibit curiosity, honesty, openness, and skepticism.
- View science and technology thoughtfully.

Computation and Estimation Skills

- Manipulate numbers mentally.
- Translate from common fractions to decimals.
- Estimate measurements and computations.
- Judge whether measurements and computations are reasonable.
- Understand the purpose of each step in a calculation.
- Determine the units in which an answer should be expressed.
- Estimate probabilities of outcomes.

Manipulation and Observation Skills

- Use common tools.
- Operate common audio equipment.
- Make simple models and equipment.
- Repair things.
- Keep a notebook that describes observations and distinguishes these from speculations.
- Calculate and compare areas and volumes.
- Read analog and digital meters on instruments.
- Disassemble and reassemble simple mechanical devices.
- Understand the purposes of the parts of simple mechanical devices.

Communications Skills

- Describe and compare things in terms of number, shape, texture, size, weight, color, or motion.
- Draw pictures that correctly portray observations.
- Write and illustrate instructions to carry out a procedure.
- Use numerical data in descriptions.
- Organize information in simple tables and graphs.
- Read tables and graphs of all kinds.
- Locate information in reference books, newspapers, magazines, CDs, databases, and the Internet.
- Make and interpret scale drawings.

Critical Response Skills

- Support statements with facts from books or other sources and identify the sources.
- Recognize faulty comparisons.
- Seek evidence for believing something and discount reasons based on hearsay or speculation.
- Question claims built on vague attributions.
- Compare consumer products.
- Be skeptical of arguments based on very small samples of data, biased samples, or samples not matched with controls.
- Notice and criticize the reasoning of faulty arguments.
- Check graphs to see that they do not misrepresent data.
- Compare probabilities with chance.
- Insist that critical assumptions behind an argument be made explicit.
- Recognize arguments based on selected data.
- Suggest alternative ways of explaining data.

The foregoing list, while long, does not cover every conceivable habit of mind, but it does provide you with the insight and understanding necessary to be able to successfully teach a set of identified and organized thinking skills to your students.

Lesson 12

Brilliant Butterflies, Drab Moths

Teacher Lesson Page

Science Literacy Skills

- Locate information in reference books, newspapers, magazines, CDs, and databases
- Make and interpret scale drawings

Vocabulary

chrysalis **pupa**
larva **proboscis**
metamorphosis

Background: Butterflies and Moths

Although most of us are much more familiar with butterflies than with moths, there are many more different species of moths than there are butterflies. Together, they make up the second largest insect order (more than 100,000 species).

Butterflies and moths make up the insect order Lepidoptera. The name comes from the Greek *lepis* meaning scale, and *pteron* meaning wing. The name refers to the wing covering of minute scales that overlap like shingles. These scales form distinctive and often beautiful color patterns, especially in butterflies.

All members of this group undergo complete **metamorphosis**, a change in form from one stage to another. The four stages of their lives are egg, caterpillar (**larva**), **pupa** (**chrysalis**), and imago (adult). From the moment an egg hatches into a caterpillar, it eats voraciously. As it grows, the caterpillar sheds its skin several times. Some caterpillars mature in a month, while others require as long as two years to mature. Mature caterpillars form their chrysalis on plants, on the ground, or underground, depending on the species. Inside the chrysalis, most of the tissues of the caterpillar's body break down. New organs and tissues develop to form the butterfly. After a period of time that can range from a few days to several months, the transformation to butterfly is complete. The butterfly forces open the chrysalis and emerges. Blood flows into the veins in the wings and makes them rigid and ready for flight. Adult butterflies mate and the females then lay eggs, which starts a new life cycle. Although some butterflies live for years, many survive only days or weeks, just long enough to mate and lay eggs.

Some butterflies lay their eggs in large batches. When the young caterpillars hatch, they often live and feed together. Other species of butterflies lay their eggs singly and those caterpillars live on their own.

Most adult butterflies and moths are herbivores, or plant eaters. They can live wherever plants grow, except in extremely cold climates. All butterflies and most moths have a hollow feeding tube, called a **proboscis.** They use the proboscis to draw nectar from flowers, water, and other liquids. Some adult moths eat wood; some eat leaves; and some, such as the beautiful luna moth, don't eat at all.

For Discussion

Find out what students already know about butterflies and moths. Ask them to describe ones they have seen. Share the background information with students.

Encouraging Skill Development

A key to this lesson is the use of field guides to identify local butterflies and their food preferences. Discuss with the class how to best use field guides to identify species and foods.

Planning a Butterfly Garden

GOAL

To plan a garden that will attract butterflies and aid their survival

MATERIALS

You will need need reference books and field guides on butterflies, gardening books, and a large sheet of drawing paper.

PROCEDURE

For their survival, butterflies are becoming more dependent on people who care about preserving them. One of the ways you can help is to create a butterfly garden. The flowers of certain plants will attract adult butterflies that feed on their nectar. However, you must also include plants on which the larvae of butterflies (caterpillars) can feed.

Work in groups of two or three. First, decide where a good spot would be for a butterfly garden. Keep in mind that butterflies need a sunny location and a shallow source of water. They also need an area that is protected from strong winds.

Next, find out what kinds of butterflies live in your area. Then identify the kinds of plants that can be used to attract butterflies and feed their caterpillars. Finally, make a labeled drawing of what your butterfly garden would look like.

RECORD KEEPING: Make a list of butterflies that live in your area in a notebook. Also list the plants you would grow to attract and feed these butterflies and their caterpillars. Draw your plan for your butterfly garden on the sheet of drawing paper.

CONCLUSIONS: How did you choose the plants for your butterfly garden? How did you provide the butterflies with a source of water? Why should butterfly gardens be located in sunny, protected areas?

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APPLICATION: Why do you think it would be important to select plants that bloom at different times for your butterfly garden?

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Name _____

Date _____

Where to See Butterflies

More species of butterflies live in the tropics than anywhere else. But must you travel to a rain forest to see a wide variety of butterflies? The answer is no, if you know where to go. Use reference sources to find out where you can go to see displays of butterflies. At some places, called butterfly houses, visitors can watch living butterflies in all stages of their life cycle. Other places, natural science museums, display mounted specimens of butterflies. Compile your list of places to visit and list each below, along with its location and a few important facts a visitor would need to know.

Lesson 14

Bats: Friends or Foes?

Teacher Lesson Page

Science Literacy Skills

- Locate information in reference books, newspapers, magazines, CDs, and databases
- Support statements with facts from books or other sources and identify the sources
- Seek evidence for believing something and discount reasons based on hearsay or speculation

Vocabulary

echolocation

Background: Bats

The oldest fossils found of bats are about 50 million years old, and the fossils closely resemble those living today. Bats are the only mammals that can fly. The nearly 1000 species of bats make up about one fourth of all mammal species. Bats are found nearly everywhere except in extreme desert and polar regions.

Bats belong to the order of mammals called Chiroptera. The group Megachiroptera are found only in the Old World tropics, while the group Microchiroptera is found worldwide.

Most bats navigate and communicate using high-frequency sounds. Their **echolocation** systems allow them to avoid obstacles as fine as a human hair in total darkness.

About 70 percent of bat species are insectivorous, but many tropical species feed on fruit or nectar. Some species are carnivorous and feed on fish, frogs, mice, or birds. There are only three species of vampire bats, which feed on blood, and they are found only in Latin America.

Bats are both environmentally and economically important. More than 300 plant species in the tropics rely on the pollination and seed dispersal by bats. Included in this group of plants are bananas, avocados, dates, figs, peaches, mangoes, cloves, cashews, and tequila. Seeds dropped by bats in the tropics account for most regrowth of forests on cleared lands. And a single little brown myotis bat of North America can consume up to 600 mosquitoes in an hour. Other insectivorous bats consume huge quantities of crop pests such as cucumber beetles, potato beetles, and moths.

For Discussion

Ask students for adjectives they would use to describe bats. List the words on the chalkboard. Then discuss which words on the list have a negative connotation and which are positive. Ask students to tell how they feel about bats.

Encouraging Skill Development

Bats are one of the most feared and misunderstood species. Help students realize the importance of looking critically at evidence about bats and help them realize how bats are important in many ecosystems.

A World Without Bats

GOAL	MATERIALS
To investigate how the world would be different without bats	You will need reference materials on bats and writing paper.

PROCEDURE

Work with a partner. Research information on different kinds of bats that live around the world. Find out how each kind of bat helps or harms people. Then write a story about a world in which bats no longer exist. Give your story a title. Make a cover for your story with the title and the authors' names. You may illustrate the cover and your story if you want to. When you have finished your story, share it with classmates.

RECORD KEEPING: Write the information you gather about each kind of bat in a notebook. Write your story on writing paper.

CONCLUSIONS: What conclusions can you make about whether bats are friends or enemies of people? Would you prefer to live in a world without bats? Why or why not?

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APPLICATION: Imagine you are considered a bat expert. A local farmer calls and asks you how to get rid of a colony of bats living in a small cave next to his vegetable fields. What advice would you give the farmer about the bat colony? Should he try to get rid of the bats? Why or why not?

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Name _____

Date _____

You Are the Bat Expert

1. Imagine that the county government wants a mining company to close up the opening to an abandoned mine. The county is concerned that the mine entrance poses a safety hazard to people who might wander into the mine and become lost or injured. You have examined the mine and discovered that a colony of big brown bats spends the winter in hibernation in the mine. Research ways to protect both the people and the bats. Describe the idea you think is best below. Make a drawing if you wish.

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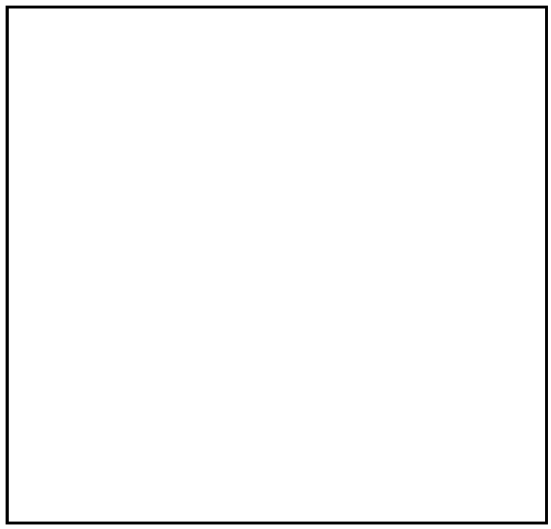

2. A friend calls you and says that there is a bat flying around in his house. He wants to know what he should do. Use reference sources to find suggestions. What advice would you give your friend?

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