Dig In!

Hands-On Soil Investigations

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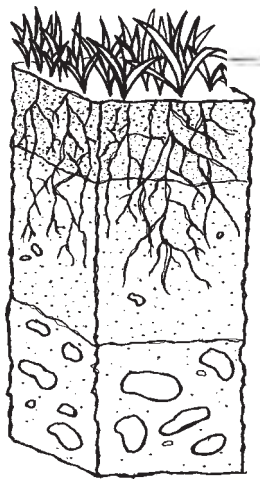

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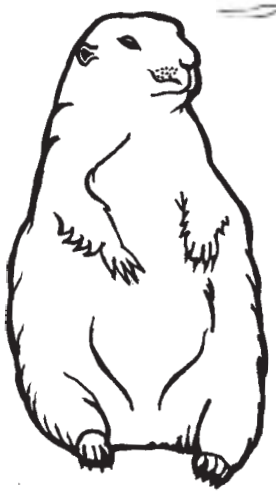

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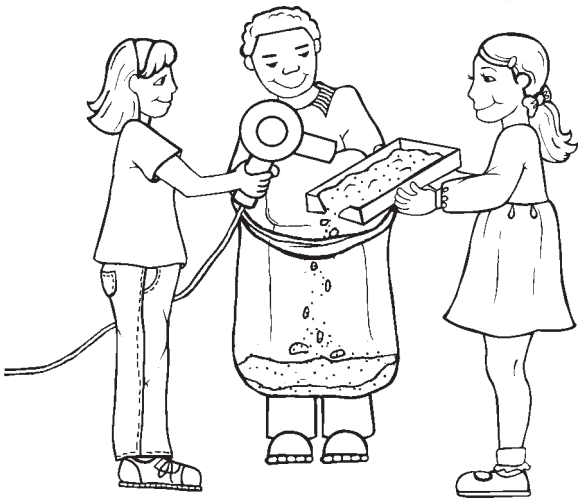

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Preface

Nature offers many moods: the serenity of running water, the seasonal color change of leaves, the violence of a howling blizzard, the movement of animals in flight, the pastoral beauty of a landscape, the kaleidoscope of colors in a desert sunset. But as we enjoy the natural world, we don't often think of one very important part: the soil. Soil is the substance in which most of our food is grown or raised. Soil is also the mud that squishes under our shoes after a rainstorm, and the grit that grazes our faces as the wind whips across a dry landscape. Soil provides space for our buildings and communities, but also is the substance that muddies our rivers when we don't properly care for the land.

Soil results from a complex series of geological, human, and biological forces. It is a tangible and traceable record of these forces. This record is illustrated by the color, feel, odor, and even the taste differences of the world's thousands of soils.

The Natural Resources Conservation Service (NRCS) has collaborated with the National Science Teachers Association (NSTA) on *Dig In! Hands-On Soil Investigations* for elementary science teachers and supervisors. The activities in *Dig In!*, designed for students in kindergarten through fourth grade, introduce soil's mysteries in an enjoyable and educational way.

As you use these activities, you and your students will gain a greater appreciation for the value of soil. Such an understanding is critical if today's students are to become informed decision-makers and conservers of our natural resources.

Acknowledgments

Dig-In! Hands-On Soil Investigations is a co-publication of the Natural Resources Conservation Service (an agency of the U.S. Department of Agriculture) and the National Science Teachers Association.

This book was conceptualized by the former NRCS Educational Relations Staff and by Agri-Education, Stratford, Iowa, under contract with NRCS. Paul DuMont and Theodore Kupelian (Educational Relations Staff) and Thomas Levermann (NRCS) incorporated new ideas and product direction. Other former agency staff contributing to the initial development of *Dig-In!* include Hubert Kelly and Duane Bosworth. Lesson 9: Watching Worms was adapted from a *Science and Children* article by Lori Gibb (Noah Wallace School, Farmington, Connecticut). Sandra Laskey wrote and illustrated two special stories for teachers to read to students.

NRCS soil scientists, including Dr. Richard Arnold, Dr. Hari Eswaran, Dr. Sheryl Kunickis, and Soil Survey Division Director Horace Smith, reviewed various drafts of *Dig-In!* NRCS Earth Team volunteers contributed to the further development and refinement of *Dig-In!* Greg Donaldson developed and refined the initial publication design, and Barbara Levermann provided extensive proofreading and editorial review.

Dig-In! was thoroughly reviewed and tested by educators. In addition to the numerous educators who advised NRCS during the book's development, the book was reviewed by Rhonda Bajalia (Crown Point Elementary School, Jacksonville, Florida), Betsy Benz (Wickliffe Elementary School, Wickliffe, Ohio), Dr. E. Barbara Klemm (Associate Professor of Education, University of Hawaii at Manoa), and David Brown (St. Peter School, Quincy, Illinois). Special thanks also go to Melody Orban (Elementary Science Resource Teacher, Kenosha Unified School District, Kenosha, Wisconsin) and the following teachers for testing these activities with their students: Kimberly George, Mary Pilot, and Steve Plato (Bain Elementary School, Kenosha, Wisconsin); Judith Herr (Grewenow Elementary School, Kenosha, Wisconsin); Corinne Nelson and Debbie Schuebel (Harvey Elementary School, Kenosha, Wisconsin); Kathy Leffler (Jefferson Elementary School, Kenosha, Wisconsin); and Gigi Bohm and Sharon Tilton (Union Grove Elementary School, Union Grove, Wisconsin).

The NRCS project manager for *Dig In! Hands-On Soil Investigations* was Thomas Levermann, Head of Education and Publications, Conservation Communications Staff. At NSTA, the project editor was Jessica Green. Also at NSTA, Linda Olliver designed the book and the cover, Tracey Shipley and Joanne Cunha created line art, Nguyet Tran did book layout, and Catherine Lorrain-Hale coordinated production and printing of the book.

How to Use This Book

These activities are designed to heighten student awareness of the value of soil. The focus of information and activities should not be on getting the right answers, but on asking the right questions. All reasonable ideas given by students are acceptable.

Concepts and Vocabulary

Significant words are italicized in the Teacher Background of each lesson and are also defined in the glossary (Appendix A). These key words allow classroom teachers to match the skill and instructional areas required by school boards with activities contained in each lesson. You will also find tables on the following pages correlating each lesson with other disciplines, the *National Science Education Standards,* and the *Benchmarks for Science Literacy*.

Adapt the teaching methods in each lesson to your classroom's individual needs. You might use vocabulary lists, word charts, and concept maps to help students relate ideas and understand key terms.

Planning

Each lesson has a special emphasis and builds upon previous lessons, although each may be used separately. The lessons include background information and guidelines for conducting the activities. Each lesson is made up of five short activities that correspond to the stages in a student's learning cycle. The *Dig In!* learning cycle is adapted from the 5 E instructional model (Trowbridge and Bybee 1995).

1. *Perception:* students discuss ideas
2. *Exploration:* students engage in hands-on investigations of concepts
3. *Application:* students communicate ideas and apply ideas to a new situation
4. *Evaluation:* students' knowledge is assessed
5. *Extensions* (optional): students expand their understanding of concepts

Each Learning Cycle activity requires approximately 30 minutes. The directions for planning and conducting activities include estimated times, but the actual time will vary depending on your pupils' age and abilities and on material availability. Make sure students have plenty of time to explore and experiment, especially during the Exploration and Application stages.

Students can work individually or in groups. Dividing your class into groups will reduce the amount of materials and preparation time needed, and may help students learn the concepts. When conducting activities in groups, remind the class that everybody has strengths and weaknesses and that each group

member should participate, cooperate, and contribute to the success of the group.

Think about ways to make the activities and learning fully accessible to all students, including those with special needs.

Materials

The activities call for inexpensive, low-impact items such as plastic jars, lids, egg cartons, and rocks. Before introducing each lesson, ask students to bring materials from home and send a note to parents explaining why these items are needed. Use recycled products and reuse items as much as possible. The materials list in each lesson gives the items necessary for the first four activities of the Learning Cycle, but not for the optional Extensions at the end of each lesson.

Soil is required for Lessons 1, 2, 3, 6, 9, and 10. In some areas of the United States, soil use is restricted because of concern about transporting agricultural pests and invasive species into vulnerable ecological areas. Check local regulations concerning the use and transportation of soil before you conduct these lessons. Ask the school custodian, a greenhouse or nursery, construction business, or a local NRCS or USDA Office for donations of or suggestions on how to obtain samples of silty, sandy, and clayey soil. In Lessons 1 and 2, your class will sample soil from the school yard. Before you start these lessons, secure permission from school administrators and custodial staff to take soil from the school grounds.

Do not substitute potting soil—because it has been sterilized, potting soil does not contain the items found in natural soil.

Only once, in Lesson 1, is it appropriate to use the word “dirt.” After that, the proper term is “soil.”

Stories

Lessons 6 and 8 include stories to read to students as an optional Extension activity. The stories are preceded by suggestions for activities that will reinforce the concepts in the stories and the lessons.

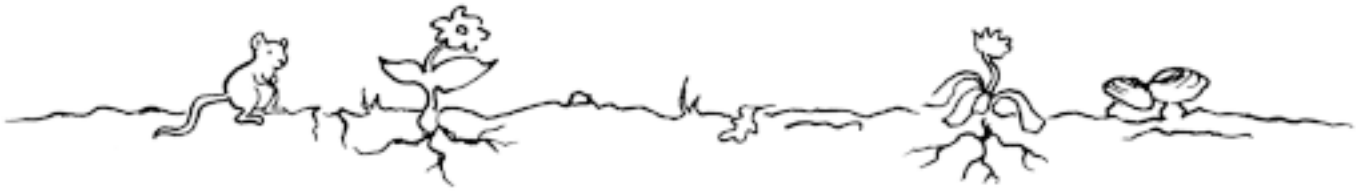
SECTION 1

What Is Soil?

Overview

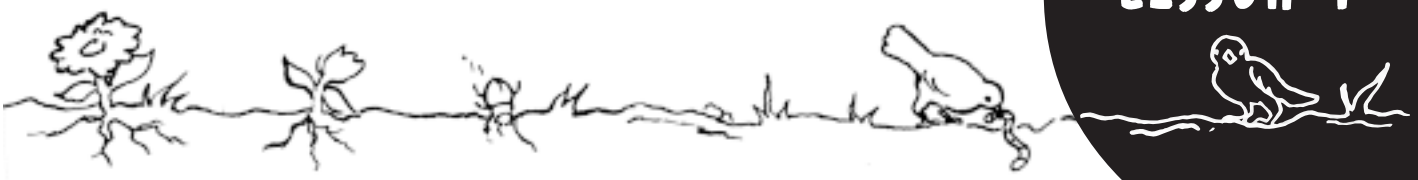
Soil is the solid material on Earth's surface that results from the interaction of weather and biological activities with the underlying geologic formation. Soil is produced from broken down rocks, organic matter (decayed animal and plant life), water, and air. Soil generally loosens from its parent material at a rate of one centimeter every 250 to 2,500 years.

Nearly 21,000 soil types are found in the United States. All soil types are made of varying amounts of three main components—silt, sand, and clay—and can therefore be classified as silty, sandy, or clayey soils. Many different colors can be present in soil, and depend on the minerals found in the parent material and on the chemical and biological reactions within the soil.



Each soil type is suited for a different use. Some soils, for example, can support the massive weight of buildings, shopping centers, airports, and highways. Some are best for crops or ranging land, some for wildlife habitat and forests. Soil scientists determine the capabilities of different soils based on texture, structure, depth, slope, organic matter, and chemical composition.

Soil is normally found in layers. Soil layers are distinguished by different colors, textures, and structures. Soil layers also have different amounts of plant and animal material (called "organic matter") and gravel.



LESSON 1

Soil Searching

Lesson Description

Students collect and handle samples of clayey, silty, and sandy soil.

Subjects

Art, Language Arts, Science

Time

Prep: 30 minutes
Activities: 1 ¾ hours (not including Extensions)

Teacher Background

This lesson encourages students to think about the differences in *soil*. Soil is a naturally occurring mixture of *organic matter*, water, air, and minerals that forms on the surface of the land.

At first, most young learners make no distinction between soil and *dirt*. However, the differences should become clear with more careful thought. Dirt is soil that is out of place in the human world; for example, dust on the floor or mud on your shoes is often called dirt. Soil is the useful substance in which our food grows; the outermost solid surface of Earth that supports our cities, houses, and highways; and the medium that contains the minerals for plant and animal life. This thin layer of material may mean the difference between poverty and prosperity—even life and death—for all who inhabit the planet, since soil is the medium in which most of our food is grown.

There are three main components of soil: *clay*, *silt*, and *sand*. Clay is the smallest particle, with less than a 0.002-millimeter diameter. Silt particles are between 0.002 and 0.005 millimeters in diameter, and sand is the largest particle, ranging from 0.05 to 2.0 millimeters. Each soil has a characteristic *texture* that

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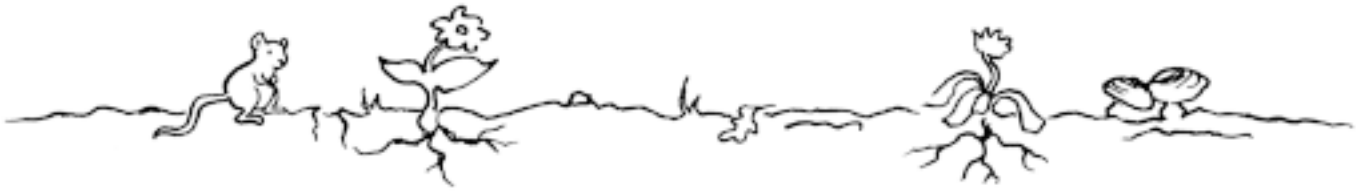


Student Objectives

Students will be able to:

- differentiate between soil and dirt;
- recognize three basic soil components through sight and touch; and
- identify the materials in soil.

depends on its main component: *clayey* soils are fine, but may turn sticky and form a lump when wet, *silty* soils are smooth like flour but crumble when wet, and *sandy* soils are grittier than the others.

Students may find the following materials in soil: wood, rocks, roots, leaves, seeds, pods, stems, bark, grass, corn cobs, insects, insect eggs, and worms. Students will also find that soil's *pore spaces* contain air, and that at certain times soil also holds moisture.

Materials

For the Class

- White glue
- Three index cards
- Clayey, silty, and sandy soils (see page x)
- Permanent marker
- Newspaper
- Two clear plastic jars with lids—e.g., tennis ball containers
- Small rocks
- Squeeze bottle
- Water
- Bucket
- Golf ball
- Softball
- Basketball

Learning Cycle

Perception: 30 minutes

1 Ask students about the difference between soil and dirt. Help students understand that people think dirt is a nuisance. "Dirt" is a negative term while "soil" is a positive term for something useful. Dirt can be dust on the floor and mud on shoes; soil is the medium in which plants grow and animals live, a material without which people can't survive.

2 Demonstrate that soil contains air by filling a plastic jar half-full with soil. Slowly add water to approximately two centimeters from the top of the jar; air bubbles will rise as water displaces the air in the soil. Ask students why the air bubbles occur and guide them to the correct answer—that soil contains air. The air is contained in pore spaces in the soil.

3 Demonstrate that soil forms from the breakdown of rocks: put small clean rocks into a jar of water, then cover and shake vigorously. The water should turn cloudy as soil particles loosen from the rocks. Ask students to observe the jar carefully and then discuss their observations.

4 Clean up by emptying the two jars into the bucket, than dispose of the wastewater outside rather than in the sink or trash.

Exploration: 30 minutes

Prep Cover a demonstration table with newspaper. Spread a dollop of glue on each of the three index cards. Sprinkle one type of soil on the glue on each of the cards and use a marker to label samples "silty soil," "sandy soil," and "clayey soil." Allow index cards to dry.

Prepare student work areas by covering tables with newspaper. Each work area should have dry paper towels, damp paper towels, a magnifier, a spoon, and three labeled cups each filled halfway with the different soils.

1 Distribute hand magnifiers. Demonstrate how to use the magnifiers and allow students to examine clothing, newsprint, or their fingers for a few minutes.

2 Have students put on their smocks or shirts, then dump the silty soil onto a dry paper towel and examine the soil with magnifiers.

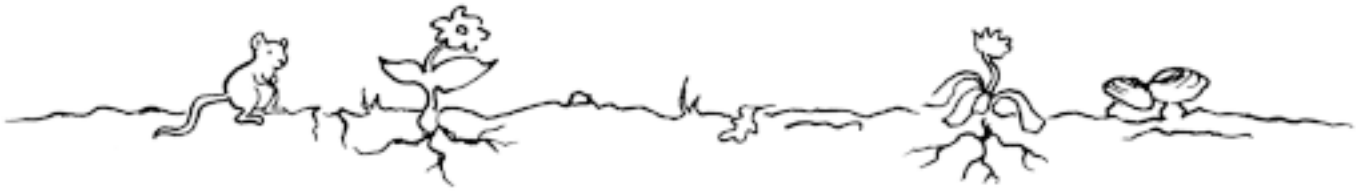
3 Ask students what they see in the soil, and list the discoveries on the board. Help younger students distinguish pieces of rocks, plant material, and twigs. By touching the soil, students may discover that their soil samples contain moisture.

4 Discuss the texture of the silty soil. Ask students to suggest words that describe how the soil feels on their fingers.

Materials Cont'd.

For Each Student Group

- Clayey, silty, and sandy soils (see page x)
- Three clear plastic cups
- Spoon
- Small plastic hand magnifier (approximately 5x magnification)
- Paper towels
- Resealable plastic sandwich bag
- Smocks or old shirts



5 Demonstrate how to use a spoon to scrape the silty soil into a neat pile on its paper towel and then ask students to do the same.

6 Tell your students that they just looked at one type of soil. Ask students to predict what the other two types of soil will contain. You may wish to list predictions on the board.

7 Repeat the discovery process with sandy soil and clayey soil.

8 Guide students to figure out which soil particle—clay, silt, or sand—is largest based on their discoveries. (Answer: clay is the smallest, sand is the largest.)

9 Model the size difference between particles using three types of balls: if a clay particle is represented by a golf ball, then a silt particle would be the size of a softball and a sand particle would be the size of a basketball.

10 Clean up, saving the materials on the demonstration table and work areas for the Application section. Make sure students wash their hands.

Application: 30 minutes

Prep Use the demonstration table and work-area setup from the Exploration section.

1 Ask students to predict what might happen to each pile of soil as drops of water are added. List student predictions on the board.

2 Add a few drops of water from a squeeze bottle to students' soil piles, and ask students to observe and describe what happens.

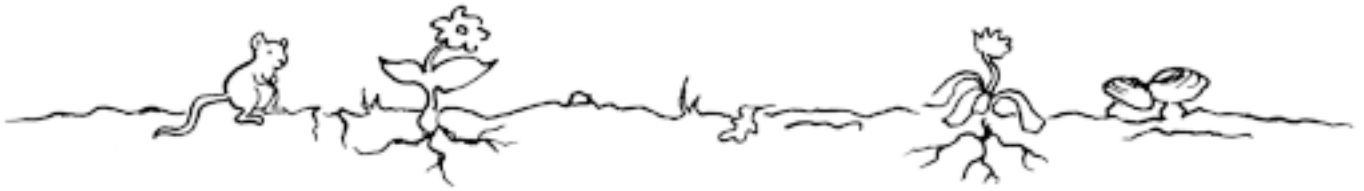
3 Have students make three soil balls using soil from each pile. Students should wipe their hands on damp paper towels between handling different soils.

4 Ask students to describe what happens when they make soil balls. Students should discover that wet clayey soil forms a lump, wet silty soil crumbles easily, and wet sandy soil runs through their fingers. Discuss observations and write results on the board. Explain that soil's reaction with water is a model for what happens when rain falls on different kinds of soil in our yards, gardens, and fields.

5 Clean the demonstration table and work areas. Keep the piles of dry, unused soil for Lessons 2, 3, 6, 9, and 10, which also require soil. Collect wet and mixed soil in the bucket, then dispose of the waste material outside.

Evaluation: 15 minutes

Students should be able to describe the difference between dirt and soil, and compare silty, sandy, and clayey soil. They also should be able to identify some of the materials in soil based on their observations and discussions. Younger students can draw and color the three components of soil, while older students might label drawings of soil and choose the appropriate vocabulary words from a list that you provide (e.g., *dirt*, *soil*, *silty soil*, *sandy soil*, *clayey soil*, *pore space*, *rock*, *organic matter*, *twig*, *color*, *texture*). Figure i.4 on page xvii (in the introduction to this book) shows an example of a rubric you might use to assess your students.



Extensions: 30 minutes each

- Investigate settling rates of soil. Fill three jars three-quarters full of water and add a few drops of Calgon® bath gel or biodegradable liquid dish soap to each jar (soap speeds up settling). Add silty soil to the first jar, sandy soil to the second, and clayey soil to the third. Label the jars with tape and a permanent marker. Ask students to predict what will happen when the jars are shaken. Cover, shake the jars, and allow the soil to settle. Were students' predictions correct?
- Make mud pies. Students should first guess which soil would make the best mud pie, based on what they have learned. (Answer: clayey soil, because it sticks together when wet more than the other soils.) Demonstrate how to make a mud pie with clayey soil and water. Have students make a pie, then press a leaf into it to make a pattern or decorate the pie with other plant material. Explain that in nature, leaves and twigs land on the soil, eventually break into tiny pieces, and become a part of the soil, making the soil loose and dark.
- Take soil samples. Bring the class outside and dig a small hole in the ground, several centimeters deep. Have students feel the soil samples for moisture. If possible, repeat this activity throughout the year, and relate the soil moisture to precipitation, temperature, and season.