SOIL AND WATER CONSERVATION TEACHING
ACTIVITIES FOR EARTH SCIENCE

A Field Report
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The Graduate School of Education
Drake University

In Partial Fulfillment
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Master of Science in Education

by
Timothy J. Kautza
August 1988
SOIL AND WATER CONSERVATION TEACHING

ACTIVITIES FOR EARTH SCIENCE

by

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SOIL AND WATER CONSERVATION TEACHING
ACTIVITIES FOR EARTH SCIENCE

An abstract of a Field Report by
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August 1988
Drake University
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The purpose of this project is to enhance the teaching of soil and water conservation in secondary school earth science courses by constructing and making available to teachers suitable, relevant teaching activities. An informal survey conducted by the Soil and Water Conservation Society of secondary school earth science teachers and members of environmental education organizations revealed a need for secondary school soil and water conservation teaching units and activities. A review of eight earth science textbooks confirmed this lack of suitable teaching activities. Probable deterrents to the use of soil and water conservation units by teachers were identified and activities were designed to overcome them. Teacher editions of eight commonly used earth science texts were examined to identify in each instructional objectives related to soil and water resources. Activities were designed to meet the objectives cited in each text in the context of soil and water conservation. The activities are presented in booklet format which includes a schematic to direct the users of cited texts to activities suitable for the attainment of objectives specific to those texts. The booklet is organized by chapters of related objectives so it can also be used independent of the cited texts.
INTRODUCTION

Purpose

This project was undertaken to accomplish five goals:

1. To meet an identified need for soil and water conservation activities in secondary Earth Science courses.

2. To present the activities in an instructional sequence that when followed would lead to a comprehensive unit on soil and water conservation, and that also would allow teachers to select particular activities to achieve instructional objectives specified in their course textbooks or curriculum guides.

3. To utilize direct-sensory instructional activities as much as possible.

4. To design the activities that would require little teacher preparation time.

5. To minimize expense of conducting the activities by utilizing inexpensive and readily available equipment and materials in the activities.

Rationale

An unpublished informal survey conducted by the Soil and Water Conservation Society, headquartered in Ankeny, Iowa, of secondary school earth science teachers and members of environmental education organizations revealed a lack of, and need for, secondary school soil and water conservation teaching units and activities (Soil and Water Conservation Society, 1982). A review of eight commonly used earth science textbooks confirmed this lack of soil and water conservation activities.
Formal surveys and case studies conducted in the last ten years have revealed that science textbooks are viewed by teachers as the primary source of science knowledge and learning activities for students and as the primary source of instructional activities for teachers. Research also shows that teachers' use of textbooks, lectures, and discussion is more widespread and frequent than is the use of manipulative materials and direct-sensory activities. Reasons cited for the predominance of these teaching methods included (1) lack of funds for purchase of sophisticated equipment and supplies thought by teachers to be required for direct-sensory activities and (2) lack of adequate time to plan such activities (Helgeson, Blosser, and Howe, 1978; Stake, 1978; Weiss, 1978).

These probable deterrents to the use of soil and water conservation activities by teachers were overcome by developing teaching activities tied to the instructional objectives in commonly-used earth science texts. These activities are direct-sensory because such activities are widely recognized as the most effective science teaching methods. To minimize expense, inexpensive and readily available equipment and materials are utilized in the activities. To minimize teacher preparation time detailed directions are given for each activity.

Methods

Teacher editions of eight commonly used earth science texts were examined to identify in each instructional
objectives related to soil and water resources. Activities were designed to meet the objectives cited in each text in the context of soil and water conservation.

Each activity consists of:

1. Rationale for the activity
2. Knowledge objectives
3. Process objectives
4. Materials needed to do the activity
5. Time approximation to do the activity
6. Directions for doing the activity
7. A student activity sheet (when appropriate)

The activities are organized within five soil and water conservation chapters:

1. Soil--We Can't Live Without It
2. Soil Properties and Characteristics
3. Soil Formation
4. Land Use and Misuse
5. Soil and Water Conservation Issues

The activities are presented in booklet format which includes a schematic to direct the users of cited texts to activities suitable for the attainment of objectives specific to those texts. The booklet is organized by chapters of related objectives so it can also be used independent of the cited texts as the basis for a soil and water conservation teaching unit.
Bibliography

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SOIL AND WATER CONSERVATION TEACHING

ACTIVITIES FOR EARTH SCIENCE

How to Use This Activities Manual

This manual is designed to help teachers of earth science incorporate soil and water conservation teaching activities into a textbook-oriented curriculum and also to help teachers present a comprehensive unit on soil and water conservation which requires minimal preparation time and expense.

Earth science teachers who wish to incorporate soil and water conservation activities into their textbook-oriented curriculum should refer to the schematic below, locate the appropriate textbook title, and select desired soil and water conservation activities from this manual to achieve the instructional objectives stated in their texts.

Teachers who wish to present a comprehensive unit on soil and water conservation can simply begin their unit with Chapter 1 and proceed through Chapter 5.
<table>
<thead>
<tr>
<th>Text/Objectives</th>
<th>Chapter No.</th>
<th>Lesson No.</th>
<th>Activity No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepts and Challenges in Earth Science. CEBCO, Allyn Bacon, 1986</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 4 &quot;Wearing Down the Earth&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explain how soil is a product of weathering and organic processes...</td>
<td>3</td>
<td>1</td>
<td>1-6</td>
</tr>
<tr>
<td>2. Describe different kinds of soil in terms of textures, layering, pH, and climate...</td>
<td>2</td>
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</tr>
<tr>
<td>3. Name the chemicals commonly found in soil, as well as life forms...</td>
<td>2</td>
<td>2</td>
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</tr>
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<td>Unit 5 &quot;Agents of Erosion&quot;</td>
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<tr>
<td>1. Describe how running water causes erosion of some landforms and the deposition of others...</td>
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<td>2</td>
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<td>2. Understand how winds may move particles of earth, changing the land...</td>
<td>4</td>
<td>1</td>
<td>3</td>
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</tbody>
</table>
Earth Science. Addison-Wesley, 1987

Chapter 9, Section 1 "Weathering"

1. Distinguish between physical and chemical weathering...................... 3 1 1-6
2. Identify factors that affect rates of weathering................................. 3 1 1-6
3. Distinguish layers in a soil profile........................................... 2 2 1-2
4. Relate soil formation to physical and chemical weathering...................... 3 1 1-6


Chapter 16 "Weathering and Erosion"

1. Describe the three major weathering processes................................. 3 1 1-6
2. Cite examples of weathering...................................................... 3 1 1-6
3. Describe what erosion is................. 4 1 2-3
4. Explain the role of gravity in moving
the earth material downhill................ 4 1 4
5. Describe how wind erodes the land.... 4 1 3
6. Cite examples of wind erosion.......... 4 1 3

Chapter 24 "Your Environment Earth"
1. Describe how land is used............. 4 1 1.5
2. Describe soil and how it is made...... 2 1 1-5
3. Explain what makes good growing soil... 2 1 4
4. Identify ways farmers protect soil..... 4 1 2-3


Chapter 5 "Weathering and Erosion"
1. Explain how soil is formed............. 3 1 1-6
2. List three ways in which gravity can
cause rocks and soil to move............. 4 1 2-4
Chapter 13, Section 1 "Weathering"

1. Describe what is meant by the term weathering. ............................................. 3 1 1-6

2. Name and describe the five processes that cause mechanical weathering. ........ 3 1 1-6

3. Explain how rocks are decomposed by chemical weathering. ......................... 3 1 2

Chapter 13, Section 2 "Soil Formation"

1. Discuss the importance of soil. ............... 1 1 1-2

   Describe how soil is formed by weathering and the actions of living organisms. .... 3 1 1-6

3. 2 1

Chapter 13, Section 3 "Soil Composition"

1. Name the most abundant minerals in soil. ...................................................... 2 1 5

2. Describe the three types of soil horizons. .................................................... 2 2 1-2

3. Discuss some of the factors involved in the formation and composition of soil. .... 3 1 1-6

3 2 1
Chapter 13, Section 4 "Soil Types"

1. Explain how geologists classify soil.... 2 2 1

2. Name the different soil types found in
   the United States....................... 2 2 1-2

Chapter 14, Section 1 "Changing the Earth's
Surface"

1. Define erosion........................... 4 1 2-4

2. Define deposition......................... 4 1 2-4

3. Discuss how erosion and deposition can
   change the earth's surface features...... 4 1 2-4

Chapter 14, Section 3 "Wind"

1. Explain where wind erosion most fre-
   quently occurs............................ 4 1 3

2. Describe the importance of windbreaks...
   4 1 3

Chapter 14, Section 4 "Running Water"

1. Explain how running water causes erosion.. 4 1 2

Chapter 20, Section 2 "Land and Soil Resources"

1. Describe the various ways land is used... 4 1 1-5
2. Describe ways land and soil can be conserved and reclaimed.................. 4 1 1-5

Earth Science. Scott, Foresman, and Co., 1986

Chapter 13 "Weathering of the Earth's Surface"

1. Describe causes of physical weathering.. 3 1 1, 3-6
2. Explain how water, oxygen, and acids affect rocks in chemical weathering....... 3 1 2
3. Describe soil textures and zones....... 2 1 1-2, 4
4. Compare three major soil types......... 2 2 1-2

Chapter 14 "Erosion"

1. List the agents of erosion.............. 4 1 1-4
2. Explain how gravity alters the land- scape........................................... 4 1 4
3. Explain the role of wind in eroding land.. 4 1 3

Earth Science. Silver Burdett and Gin. 1982

Chapter 4 "Weathering"

1 Identify and describe the physical forces of weathering......................... 3 1 1, 3-6
2. Describe how chemical reactions occur in nature.

3. Describe the effects of chemical reactions on minerals.

*Experiences in Earth-Space Science*, Laidlaw Bros., 1985

Chapter 23 "Weathering and Erosion"

1. Define the term "physical weathering" and list three causes of physical weathering.

2. Explain that water is probably the greatest cause of physical weathering and give at least two examples of how water causes it.

3. Define the term "chemical weathering" and list three causes of chemical weathering.

4. Describe two kinds of particles that may result from the weathering of rock.
5. Explain how soil is formed.

6. List the three soil horizons in correct order from top to bottom and describe characteristics of each layer.

7. Define the terms "erosion" and "deposition".

8. Tell how moving water changes the surface of the land.

9. Tell how erosion and deposition by wind can affect plants and animals.

Chapter 25: "Treasures of the Earth"

1. List examples of how land, soil, and minerals are important resources.

Chapter 26: "People and the Environment"

1. Describe soil as being made up of mineral matter and organic matter.

2. Tell how rich soil differs from poor soil.
Lesson Number 1: Soil: Its Meaning for Humans

**Objectives:**
1. Human life could not exist on earth without soil.
2. Soil is the source of many things we use and enjoy every day.
3. State examples of how his or her life is dependent on soil resources.
4. Explain why terrestrial life could not exist without soil.

**Process Objectives:** At the end of this lesson, each student will be able to:
- State examples of how his or her life is dependent on soil resources.
- Explain why terrestrial life could not exist without soil.

**Supplies:** You will need:
- The sound filmstrip, "Soil: Its Meaning for Man;"
CHAPTER 1

Soil -- We Can't Live Without It

Teacher's Guide

Lesson Number 1: Soil: Its Meaning for Humans

Rationale: Soil is one of our most useful natural resources. From the soil we get food, clothes, and other materials we need to live, to enjoy life, and to maintain our society. Understanding the importance of soil resources to human well-being is necessary to develop respect for the resource and concern for its maintenance.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. Human life could not exist on earth without soil.
2. Soil is the source of many things we use and enjoy everyday.

Process Objectives: At the end of this lesson each student will be able to:

1. State examples of how his or her life is dependent on soil resources.
2. Explain why terrestrial life could not exist without soil.

Time: Allow two 40-minute class periods to complete the following activities.

Activity 1: Soil -- Its Meaning for Humans -- A Filmstrip

Time: Allow 20 minutes with discussion.

Supplies:

* The sound filmstrips "Soil: Its Meaning for Man,"

-11-
(set of two). Only filmstrip No. 1 will be used in this activity. Filmstrip No. 2 will be used in Chapter 4. Available from Vocational Media Associates, Box 3000, Mt. Kisco, NY 10549; purchase price $79 with program.

Procedure:

1. Introduce filmstrip No. 1 by stating that over the next two or three weeks, they will be investigating soil, a fascinating and vitally important natural resource that is little understood by most people. The filmstrip will describe the importance of soil to human life in an ecological and a land use sense.

2. Show the filmstrip.

3. Using the program guide for the filmstrip, focus discussion on the importance of soil as a medium for plant growth, a source of food for humans and other animals, and as a purifier of water.

Activity 2: Origins -- Individual Research

Time: Allow 60 minutes.

Supplies:

* Student activity sheets

* Reference books (At least one week before you intend to do this activity ask your school librarian to compile reference books for student use. Also use student geography texts if applicable.)
* One 61cm x 91 cm piece of poster paper
* One bottle of glue
* Unwanted magazines and catalogs

Procedure:

1. Write in the center of the sheet of poster paper "From Soil." This will serve as the focal point of the collage students will make as explained below.

2. Display the reference books on the supply table.

3. Distribute to each student a student activity sheet.

4. Explain to the students that the purpose of this activity is to determine (using the reference books on the supply table and encyclopedias) what some items used frequently by humans in the United States are made of and to see if they can trace the origins of those materials to soil.

5. Review the activity sheets with the students and ask if they have questions about what they are to do.

6. Direct the students to do the activity.

7. Hang the sheet of poster paper for the collage in a place that is easily accessible to the students.

8. Ask the students to orally report their findings in class. As the origin of each item is traced to soil, ask those students who researched each
particular item to glue their pictures of it onto the poster paper. Continue until the origins of all items selected by the students have been reported.

9. Lead class discussion to reveal the origin of items not selected by students.

10. Ask students who researched items not listed on the activity sheets to report their findings and to add their pictures to the collage.

11. Summarize by pointing out that soil is the origin of many things we use and enjoy everyday. Therefore, it is one of our most important natural resources.

Student Activity Sheet

Lesson Number 1: Soil: Its Meaning for Humans

Objective: By completing this activity you will be able to list examples of how your life is dependent upon soil resources.

Activity 2: Origins

Procedure:

1. Select either three of the items listed in Procedure No. 2, or two of the items listed plus one item of your own choosing, determine what they are composed of, and see if you can trace the origins of those materials to soil resources. For example: Your answers might be reported like this:
Candy bar

* chocolate → chocolate bean → cocoa plantation in Brazil → cocoa tree → soil

* sugar → sugar factory → sugarcane field in Hawaii → sugarcane plant → soil

* peanut → peanut distributor → peanut field in Georgia → peanut plant → soil

2. Select from these items:

* alcohol
* concrete
* perfume
* baseball glove
* deodorant
* pencil eraser
* bicycle tire
* glass
* plastic
* body powder
* gum
* plywood
* charcoal
* house paint
* rayon fabric
* colored paper
* jeans
* soft drink
* computer chip
* nail polish
* writing paper

3. Use the references on the supply table, encyclopedia, or other sources of information to do this activity.

4. Cut out a picture from the magazines and catalogs on the supply table to represent each item you research for use in class tomorrow.

5. Record your answers on this activity sheet and be prepared to share your findings with the class tomorrow.
CHAPTER 2

Soil Properties and Characteristics

Teacher's Guide

Lesson Number 1: Exploring Soil

Rationale: The properties and characteristics of soils determine what uses a particular area of land is most suitable for. If soil properties and characteristics are not understood, we may use valuable, limited soil resources foolishly. For example, using our most agriculturally productive land for urban expansion while leaving less productive land for agriculture. This has happened throughout Iowa and the nation and probably in your own community.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. Soil is a natural mixture of rock particles, water, air, living organisms and decaying organic matter.

2. There are many different kinds of soil and they differ in texture, color, organic matter content, abundance of organisms, volume of pore spaces, and fertility.

3. Some combinations of soil properties and characteristics make some soils more suitable for agriculture than others.

Process Objectives: At the end of this lesson, each student should be able to:

1. Describe what soil is generally composed of.

2. Name the three sizes of soil particles.

3. Describe three ways soils differ from one another.
4. Tell how soil that is most suitable for agriculture differs from soil that is less suitable.

**Time:** Completing all the activities of this lesson will require approximately five 40-minute class periods.

**Activity 1: Soil Expedition -- A Field Trip and Class Investigation**

**Time:** Allow approximately 60 minutes at the field trip site.

**Supplies needed for each group of four or five students.**

* Two 16.5 cm x 15 cm (or larger) sealable plastic bags each with a 2.5 cm x 7.6 cm (or larger) pressure sensitive label attached.
* One student activity sheet for each student
* One small hand-held spade
* One or more magnifying glasses or hand lenses
* One squeeze-bottle filled with water
* Two or more paper towels per student
* Each student should have his or her own 14 cm x 22 cm (or larger) spiral-bound notebook and two pencils.

**Procedure:**

1. Place the supplies listed above (except for the notebooks and pencils) on the supply table.
2. Distribute to each student a student activity sheet.
3. Referring to the rationale describe the field trip site and explain why the field trip is being taken. Describe what is to be done there and
safety rules to be followed.
4. Read the student activity sheet with the students.
5. Ask the students if they have questions about what they are to do when they arrive at the site.
6. Ask one student from each group to secure the supplies from the supply table.
7. Depart. Upon arrival at the site, ask the students if they have any questions about what they are to do. Describe the boundary limits to the site and give specific instructions. Suggest some places that might be good for them to get their soil samples (i.e. low areas that are usually wet; hilltops; under trees; an area with no vegetation or less vegetation than the other areas; near a waterway; in an area that has been tilled for crops or a flower garden).
8. Direct the students to do the activity.
9. After each group has collected one soil sample describe to the class the major ingredients of soils: minerals and their particle sizes (sand, silt, and clay), organic matter (decayed or decaying plants and animals), organisms (living plants and animals), water, and air. Demonstrate the relative differences in soil particle sizes by using a basketball to represent sand-sized particles, a baseball to represent silt, and
the head of a pin to represent clay.

10. After each group has examined one sample from another group, go through each question on the student activity sheet with the entire class discussing samples of one location at a time.

11. Remind the students to keep their activity sheets for later use.

12. Ask the students to place their soil samples into the box for transport to the classroom.

13. Return to the classroom.

Activity 2: Particle Size Differences Among Soils

Time: This activity will span a three-day period.

Allow approximately 20 minutes on the first day and 20 minutes on the third day.

Supplies needed for each group.

* One 250ml measuring cup
* Soil samples from Activity No. 1
* One hand-held calculator
* One metric ruler
* Two 2.5cm x 7.6cm (or larger) pressure sensitive labels
* Two quart-sized jars
* One grease pencil
* A source of water
* Storage space for the jars in a place where they can be easily observed without being disturbed by the students for two days.
Procedure:

1. Place the supplies listed above on the supply table.

2. Explain to the students that the purpose of this activity is to determine the relative amounts of sand, silt, and clay size particles there are in each soil sample, and to determine how, if at all, the soils differ in amounts of different sized soil particles. Explain that they will separate the soil particles by mixing them in water and allowing them to settle out by gravity.

3. Distribute to each student an activity sheet.

4. Ask the students to read the activity sheet.

5. Ask the students if they have questions about what they are to do.

6. Direct the students to do Activity 2.

7. After the groups have completed Procedure No. 7 of the student activity sheet, ask the students to observe the soil particles in the jar and to describe what is occurring. (Because sand particles are largest they will settle out first. Clay particles, being the smallest, will settle out last. Organic matter, which may contain air, may float longer than any of the particles and may settle on top of the soil particles. Therefore, materials will appear in layers in the jar in this order from the bottom to the top: sand, silt, clay, and
8. Ask one student from each group to record the group's measurements in the following table on the chalkboard after completion of the activity.

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Percent Sand</th>
<th>Percent Silt</th>
<th>Percent Clay</th>
<th>Percent Organic Matter</th>
<th>Volume of Pore Space</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

9. Ask the students what conclusions they can make from the data presented (i.e. samples from low areas had more clay and less sand than samples from hilltops, soils under trees have more organic matter than soils from tilled fields.).

10. Leave the Table on the chalkboard and use it for Activity No. 3.

**Activity 3: Pore Space Differences Among Soils**

**Time:** Allow 25 minutes

**Supplies needed for each group:**

* Soil samples from Activity No. 1
* One triple-beam balance
* One hand-held calculator
* One 100ml or greater graduated cylinder, beaker, or measuring cup
* Three glass baby food jars (junior size)
* Student activity sheets for each student
* Source of water

Procedure:

1. Place the supplies on the supply table.
2. Distribute to each student a student activity sheet.
3. Explain to the students that two very important components of soil that have not been discussed in these investigations are water and air. Ask where they think water and air might be found in soil. (Pore spaces between soil particles, holes or tunnels made by living organisms like worms and ants, and in spaces where plant roots once were and remain after a plant dies and decays.)
4. Explain that the purpose of this investigation is to determine the amount of pore space in their soil samples and to see if there are differences in amounts of pore space among soil samples.
5. Ask the students to read the activity sheet.
6. Ask the students if they have questions about what they are to do.
7. Direct the students to do the activity.
8. After all groups have completed the activity and have recorded their measurements on the chalkboard, ask the students what conclusions they can make from the data presented (i.e. soils with more clay tend to have a greater volume of pore spaces; soils
with higher amounts of sand tend to have lesser volume of pore spaces).

8. Discuss the significance of volume of pore spaces with the students. Soils with relatively high clay content can hold more water than soils with relatively high sand content. Air is needed as an oxygen source by organisms in the soil.

Activity 4: Identifying Good Agricultural Soils

Time: Allow 35 minutes

Supplies:

* One student activity sheet for each student

Procedure:

1. Distribute to each student an activity sheet.

2. Ask the students to read the activity sheet.

3. Ask the students if they have questions about what they are to do.

4. Direct the students to do the activity by themselves.

5. Ask the students to compare and discuss their answers with the other members of their groups.

6. As a class discuss the relationships between soil color and the other soil characteristics in Table 1 in the activity sheet. The amount of organic matter in a soil usually has great influence on its color. The more organic matter there is the darker the soils. Organic matter provides nutrients to the soil that makes it fertile.
Organic matter helps keep soil loose and well aerated.

7. As a class discuss the relationships between soil texture and the other soil characteristics and properties presented in Table 1. Soil texture is determined by the relative amounts of each soil particle size in the soil material. The relative amounts of each particle size determines the other characteristics listed in the Table. For example soil material that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt has a clay texture. Because there is a relatively high amount of clay-sized particles, the soil material feels sticky or slick, and has a high volume of pore spaces because the clay particles are so small. For the same reason it has a high water holding capacity. Aeration is low because most of the pore spaces are filled with water.

Activity 5: Soil Minerals -- A Film

Time: Allow approximately 40 minutes with class discussion; 20 minutes for film alone.

Supplies:
* The film, "Growing Energy," available from The Fertilizer Institute, 1015 18th St., NW, Washington, DC 20036; $9.50 loan.
Procedure:

1. Introduce the film by explaining that the organic matter and mineral particles in soil contain chemicals that plants need for growth. The film will tell the basic story of plant nutrition, describe minerals required from the soil for plant growth, and explain why and how fertilizer is used.

2. Show the film.

3. Use the questions in the teacher's guide for the film to stimulate discussion on the importance to plants of potassium, phosphorus, and nitrogen in the soil.

Student Activity Sheet

Lesson Number 1: Exploring Soil

Objectives: By completing the following activities you will be able to:

1. Describe what soil is generally composed of.
2. Name the three sizes of soil particles.
3. Describe three ways soils differ.
4. Describe how soil that is most suitable for agriculture differs from soil that is less suitable.

Activity 1: Soil Expedition

Procedure:

1. In this activity you go on a field trip and explore soil outside your classroom. When you arrive at the destination of your study, you will select two
locations that are different from each other
(a low area that is usually wet; a hilltop; under
a tree; an area with no or less vegetation than
the other areas; near a place where water runs
frequently like a creek, ditch, or drainage way;
in an area that has been tilled for crops or a
flower garden.)

2. Secure from the supply table two plastic bags, one
hand-held spade, a number of magnifying glasses or
hand lenses as instructed by your teacher.

3. Also bring with you on the field trip a spiral-
bound notebook and two pencils.

4. Decide at what two different places you will take
your soil samples.

5. At the first location, using the hand-held spade,
dig up enough soil to a depth of two inches to fill
one of your plastic bags.

6. Divide the soil equally among the members of your
group and examine your portion by placing it on a
page of your notebook.

7. Answer the following questions.
   a. Describe the location where you collected the
      sample.
   b. Describe your soil.
      What color is it?
dark gray, black, brown, yellow-brown, pale brown yellow, red

(circle one)

What does it feel like after wetting a small portion of it with water from the squeeze bottle and rubbing it between your thumb and forefinger? very sticky, smooth, slick, very gritty, somewhat gritty and sticky

(circle one)

8. Draw sketches of the organic matter, minerals, and organisms you see on the other side of this sheet in the space labeled "Sample No. 1."

9. When your group has completed its exploration of your first sample, place the sample into one of your plastic bags. Make sure the bag is full and sealed. Write on the label "Sample No. 1" and your group Number.

10. Move to the other location you decided to sample and repeat Procedures No. 5-8 with your new sample. Write the answers to questions and make your drawings on the back of this sheet in the space labeled "Sample No. 2."

11. After your group has completed its exploration of Sample No. 2 place it into your unused plastic bag. Make sure the bag is full and sealed. Write on the label "Sample No. 2" and your group Number.

12. Trade one of your soil samples with one of the
other groups of students. Select one of their samples that came from a different location than your samples. Write the other group's Number, their sample Number, and the location of their sample on the back of this sheet in the place labeled "Sample No. 3."

13. Repeat Procedures No. 5-8 with this sample. Write the answers to questions and make your drawings on the back of this sheet in the space labeled "Sample No. 3."

14. Return the sample to the other group and retrieve the sample you gave them.

15. Describe how all three samples are similar.

16. Describe how the samples differ from one another.

17. Keep this activity sheet for later use.

Activity 2: Particle Size Differences Among Soils

Procedure:

1. Secure from the supply table your group’s soil samples, two quart jars, one measuring cup, and two labels.

2. On one label write your group Number and "Sample No. 1." On the other label, write your group Number and "Sample No. 2." Affix one label to each quart jar.
3. Measure approximately one cup of your soil Sample No. 1 and put it into the jar labeled "Sample No. 1." Reseal the plastic bag immediately.

4. Measure approximately one cup of your soil Sample No. 2 and put it into the jar labeled "Sample No. 2." Reseal the plastic bag immediately.

5. Add to each jar enough water to fill the jars approximately three-fourths full. Place the cover tightly on each jar.

6. Shake both jars vigorously until any lumps of soil disappear.

7. Immediately place the jars where your teacher has designated and allow them to sit there undisturbed for two days to give the soil particles time to settle.

8. On the third day, secure from the supply table one metric ruler, one grease pencil, and one calculator.

9. Decide, without disturbing the soil in your jars, where you think the sand layer ends and the silt layer begins and make a 3-cm long horizontal mark with the grease pencil on the jar at that point. Label the mark "#1."

10. Decide, without disturbing the soil in your jars, where you think the silt layer ends and the clay layer begins and make a 3-cm long horizontal mark with the grease pencil on the jar at that point. Label the mark "#2."
11. Decide where you think the clay layer ends and the organic matter layer begins and make a 3-cm long horizontal mark with the grease pencil on the jar at that point. Label the mark "#3."

12. Make a 3-cm long horizontal mark with the grease pencil on the jar at the point where the organic matter layer ends and the water begins. Label the mark "#4."

13. Using the metric ruler, determine the depths of each layer. (a) The depth of the sand layer (from the bottom of the jar to mark #1) is ______ mm. (b) The depth of the silt layer (from mark #1 to mark #2) is ______ mm. (c) The depth of the clay layer (from mark #2 to mark #3) is ______ mm. (d) The depth of the organic matter layer (from mark #3 to mark #4) is ______ mm. (e) The total depth of all the soil particles in your jar is ______ mm (the sum of answers (a), (b), (c), and (d)).

14. Using the calculator, find the percent volume of sand, silt, clay, and organic matter in each of your samples by using the following formula:

\[
\text{Percent Volume of Layer} = \frac{\text{depth of that layer}}{\text{total depth of all layers}} \times 100
\]

15. Record your calculations below.

Sample #1: ____________________________

(location of sample)
6. Calculate the mass of the soil in the jar and soil together.

7. Subtract the mass of the water from the mass of the soil added to the jar.

8. Record the mass of the water added to the soil in the data table.

9. Repeat Steps 5-8 for sample #2:

Sample #2: ____________________________

(location of sample)

10. Calculate the mass of the total mixture (from Procedure No. 4) from the mass of the soil added to the jar and the volume of the water added to the soil.

11. Calculate the mass of the water added to the soil by subtracting the mass of the total mixture from the mass of the water added to the soil.

12. Repeat Steps 6-11 for sample #2.

13. Conclude whether or not the soils are different by comparing the percentages of each layer.

14. Record your calculations from Procedure No. 15 on the chalkboard data table and indicate the location your sample was taken from.

15. Return your supplies to the supply table.

16. Keep this activity sheet for later use.

Activity 3: Pore Space Differences Among Soils

Procedure:

1. Secure from the supply table your group's soil samples, one calculator, one balance, one volume measuring device, and three glass jars.

2. Measure out 100ml of soil from your soil sample #1 using the volume measuring device.

3. Carefully pour the soil into one of the jars.

4. Determine the mass of the jar and soil together by using the balance. Record the mass. ______g.
5. Slowly pour water into the jar until the water level rises to the top of the soil.

6. Determine the mass of the mixture and jar together. Record the mass. _____ g.

7. Calculate the mass of the water added to the soil by subtracting the mass of the jar and soil (from Procedure No. 4) from the mass of the total mixture (from Procedure No. 6).

   _____ g (mass of mixture) - _____ g (mass of jar and soil) = _____ g (mass of water)

8. The mass of the water is equal to the volume of pore space in milliliters per 100ml of soil, because 1 gram of water is equal to 1ml of water. Therefore, the volume of pore space for each 100ml of your soil sample #1 is _____ ml.

9. Repeat Procedures No. 2-7 using your soil sample #2.

10. The volume of pore space for each 100ml of your soil sample #2 is _____ ml.

11. Are the volumes of pore spaces for your samples the same? _____

12. Record your calculations from Procedures No. 8-10 in the appropriate spaces in the table on the chalkboard.

13. Decide if the volumes of pore spaces of your soil samples were high, medium, or low compared to the other groups' soil samples.

   Sample #1: high medium low (circle one)
Sample #2: high medium low (circle one)

14. Return your supplies to the supply table.
15. Keep this activity sheet and your data for later use.

Activity 4: Identifying Good Agricultural Soils

Procedure:

1. Gather together your activity sheets for Activities No. 1-3.

2. Answer the following questions for each of your two soil samples using the tables below and the information you recorded on your activity sheets.

<table>
<thead>
<tr>
<th>Light-colored soils:</th>
<th>Low</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>pale brown to yellow or red</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dark soils:</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>black</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brown to yellow-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light-brown</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red-brown to yellow sandy brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yellow sandy brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yellow-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brown-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Black-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Black-brown to red-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red-brown to red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Red-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Black-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Black-brown to red-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>
TABLE 1. Soil characteristics by color.

<table>
<thead>
<tr>
<th>SOIL TYPE</th>
<th>ORGANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY COLOR</td>
<td>CONTENT</td>
</tr>
</tbody>
</table>

| Dark soils: | |
| Dark gray, | Very High | High | High (very high) | Low (very low) |
| black,      | sticky,    | smooth,| tightly that    | little is     |
| brown       |           |       | easily       |             |

| Moderately dark soils: | Medium | Medium | Medium |
| Brown to yellow-brown |        |        |        |

| Light-colored soils: | Low | Low | Low |
| pale brown to yellow or red | Smooth | Medium | Good to High |

Source: Adapted from USDA Soil Conservation Service (date unknown)
<table>
<thead>
<tr>
<th>SOIL TYPE BY TEXTURE</th>
<th>FEEL WHEN WET</th>
<th>% VOLUME POROUS SPACES</th>
<th>WATER-HOLDING CAPACITY</th>
<th>AERATION CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>Very sticky, smooth, slick</td>
<td>High</td>
<td>High (water is held so tightly that little is available for plants)</td>
<td>Low</td>
</tr>
<tr>
<td>Sandy</td>
<td>Very gritty</td>
<td>Low</td>
<td>Poor (little water is held and therefore not available to plants)</td>
<td>High</td>
</tr>
<tr>
<td>Loam</td>
<td>Smooth and slick, somewhat gritty and sticky</td>
<td>Medium</td>
<td>Good to excellent (a moderate amount of water is held and is readily available to plants)</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Adapted from USDA Soil Conservation Service (date unknown)
Sample #1

What color was the soil? _______________________________________

What texture was the soil? _______________________________________

Would you buy a farm with that type of soil on most of its fields? _____ Why? _______________________________________

Sample #2

What color was the soil? _______________________________________

What texture was the soil? _______________________________________

Would you buy a farm with that type of soil on most of its fields? _____ Why? _______________________________________

3. Explain, based on your understanding of Table 2, why pore spaces are important in soils. ______________________________________

4. Describe what you think are the best physical characteristics and properties of soil for a garden, an agricultural field, and for potting soil.

   Color: ______________________________________

   Texture: ______________________________________

Teacher's Guide

Lesson Number 2: Distinguishing Among Soils

Rationale: People are most familiar with the top layer of soil -- the layer on which plants grow, that which they till for gardens or agricultural crops. The activities in Lesson Number 1 focused on that upper layer of soil. Some soils may be more than six feet in depth with the
composition, properties, and characteristics varying throughout. When soil scientists classify soils and determine their suitabilities for different uses they consider the full depth of the soil. Soil material below the surface layer often is a major factor in determining soil suitabilities. The inherent fertility of soil material generally decreases the deeper it is located in the soil profile. Erosion of soil removes the most fertile soil material leaving less fertile soil behind.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. Soils tend to develop into layers called horizons.
2. A soil profile is a vertical cross section of a soil from the surface into the underlying unweathered material.
3. Characteristics of horizons within a soil differ from each other.
   a. The A horizon, commonly known as topsoil, is the uppermost and generally most fertile layer.
   b. Below the A horizon is the B horizon. It is generally less fertile than the A horizon, and consists primarily of materials that have leached from the A horizon.
   c. The C horizon lies below the B horizon. It is generally the least fertile horizon and consists primarily of disintegrated parent material or bed-
rock upon which it lies.

4. Similar soils are categorized into groups such as Mollisols, Aridisols, Alfisols, and Ultisols in part by what horizons are present in the soil profile, relative thickness of each horizon, and depth of the soil from the surface to bedrock.

5. The most common types of soil in Iowa are Mollisols which are deep, dark soils that are among the most productive in the world.

Process Objectives: At the end of this lesson, each student will be able to:

1. Identify and distinguish among soil profiles of a typical Mollisol, Aridisol, Alfisol, and an Ultisol.
2. Distinguish between the A, B, and C horizons of a soil profile.
3. State one characteristic of each of the three soil horizons that sets one apart from the others.

Time: Completing the two activities of this lesson will require approximately three 40-minute class periods.

Activity 1: An In-depth Look at Soils -- A Visitor Demonstration

Time: Allow 40 minutes.

Supplies needed for the entire class:

* One soil expert: Contact the local office of the United States Department of Agriculture -- Soil Conservation Service, or the soil science or agronomy departments of a local college or uni-
versity, at least one month before you would like
to do this activity and ask if someone could
come to your school to do the following.

Procedure:

1. Show and describe a soil profile.

2. Show a typical example of the most locally common
of the following soil orders: Aridisol, Alfisol,
Mollisol, or Ultisol and compare it to examples
of one or more of the other three soil orders using
soil monoliths or color slide transparencies.

3. Compare the depth to bedrock, thicknesses of soil
horizons, and inherent soil productivity for
agricultural crops for each soil order.

4. Describe characteristics of soil horizons within
a soil.

5. Demonstrate, on the school site or nearby, the
procedure for identifying soil using a bucket auger.

6. Display the soil sample so students can see and
feel it and help the students identify the soil's
horizons.

7. Help the students as a group classify the soil
as an Aridisol, Alfisol, Mollisol, or Ultisol.

Activity 2: Soil Mosaic -- A Student Illustration

Time: Allow two 40-minute class periods.

Supplies for each student:

* One sheet of poster paper approximately 61 cm x 91 cm

* One scissors
* One 12" ruler

* One *National Geographic* magazine, Vol. 166, No. 3, September 1984. These can be acquired on a loan basis from parents who subscribe or can be purchased for $2.25 each from the National Geographic Society, 17th and M Sts., N.W., Washington, DC 20036.

(An alternative: Photographic slide transparencies of Aridisols, Mollisols, Alfisols, and Ultisols might be available on a loan basis from the local office of the United States Department of Agriculture -- Soil Conservation Service or from the soil science or agronomy departments of a local college or university. If so, seek permission to duplicate the slides in color print format for individual use by students.)

* Construction paper of the following colors (scraps can be used):
  * white
  * tan
  * black
  * pale yellow
  * light gray
  * dark brown
  * light brown
  * dark gray
  * reddish brown
* One bottle of glue

* One or more paper towels

**Procedure:**

1. Diagram on the chalkboard, on an overhead transparency, or on a sheet of the poster paper the representation (Fig. 1) of what the students' posters should look like before they begin creating
Figure 1. Representation of student poster format.
their mosaics.

2. Explain to the students that they will create a mosaic to represent a soil profile of one of four general kinds of soils -- Alfisol, Aridisol, Mollisol, or Ultisol -- for display in school.

3. Place the supplies listed above on the supply table.

4. Distribute to each student an activity sheet.

5. Ask the students to read the activity sheet.

6. Ask the students if they have questions about what they are to do.

7. Direct the students to do the activity individually.

8. Ask some students to describe to the class their mosaics and to explain how each horizon is distinguishable from the others.

9. Ask the students what differences and similarities there are among Aridisols, Mollisols, Ultisols, and Al fisols.

10. Ask the students to display their posters in an area where they may view them throughout the remainder of your classes about soils.

Lesson Number 2: Distinguishing Among Soils

Objectives: By completing this and the preceding activity you will be able to:

1. Identify and distinguish among soil profiles of a Mollisol, Aridisol, Alfisol, and an Ultisol.

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2. Distinguish among the A, B, and C horizons of a soil profile.
3. State one characteristic of each of the three horizons that sets it apart from the others.

Activity 2: Soil Mosaic

Procedure:

1. Decide whether you would like to create a mosaic of an Aridisol, Mollisol, Alfisol, or Ultisol.
2. Secure from the supply table one sheet of poster paper and one ruler.
3. Draw a 33cm x 81cm rectangle on your poster paper like that done by your teacher. You will create your mosaic within that rectangle.
4. Delineate along the right side of the rectangle using a scale of measurement of 15cm equals 30cm, soil depths of 30cm to 150cm like that done by your teacher.
5. Write the name of the soil you will illustrate at the bottom of the sheet like that done by your teacher.
6. Write the word "PROFILE" at the top of the rectangle to indicate that the rectangle will reveal a profile of your soil.
7. Write the word "HORIZONS" at the top of the space to the right of the rectangle to indicate that the space will include information about soil horizons in the soil profile.

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8. Secure from the supply table one scissors, one National Geographic magazine, one bottle of glue, and one sheet each of the following colors of construction paper.
* To create an Aridisol mosaic:
  * white * light brown * light gray
  * pale yellow * tan * dark gray
* To create a Mollisol mosaic:
  * black / light brown * light gray
  * dark brown * white * dark gray
* To create an Alfisol mosaic:
  * black * light brown * light gray * tan
  * dark brown * pale yellow * dark gray * white
* To create an Ultisol mosaic:
  * dark brown * tan * reddish brown
  * light brown * white * light gray

9. Turn to page 359 in the National Geographic and locate the illustration that represents the soil you selected for your mosaic.

10. Construct a mosaic within the rectangle demonstrating the color, soil depth, and thickness of the A, B, and C horizons using the illustrations and your knowledge of soil composition as guides.

11. To the right of your mosaic label what you think are the beginnings and endings of each horizon.

12. Write under the heading "HORIZONS", and to the
right of the appropriate horizons, the characteristics that distinguish one horizon from the others (i.e. relative fertility for plant growth, composition, origin of materials, etc.).

13. Write your name on the bottom right corner of the poster when you complete the mosaic and hang the poster in the area designated by your teacher.

Bibliography


Knowledge Objectives: At the end of this lesson, each student should know that:

1. Soil formation is a very slow process.

2. Soil formation occurs by friction, freezing of water, wetting and drying, temperature changes, and the action of acids.

Process Objectives: At the end of this lesson, each student should be able to:

1. Decide whether or not soil formation is a fast or a slow process and explain the decision.

2. Name three processes that contribute to soil formation.

3. Describe how each of the processes occurs in nature.

Time: Completing all of the activities of this lesson will require approximately two 40-minute class periods.
CHAPTER 3
Soil Formation
Teacher's Guide

Lesson Number 1: Weathering

Rationale: Nearly all human food comes from plants grown in soil. But soil loss by erosion is severe in many places (Iowa) and catastrophic in others (Ethiopia).

To understand the importance of the problem of soil erosion students need to know that soil is formed very slowly but eroded very quickly. It requires hundreds of years to form 2cm of soil and this can be lost in one rainstorm. In this lesson students study the soil formation process.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. Soil formation is a very slow process.
2. Soil formation occurs by friction, freezing of water, wetting and drying, temperature changes, and the action of acids.

Process Objectives: At the end of this lesson, each student should be able to:

1. Decide whether or not soil formation is a fast or a slow process and explain the decision.
2. Name three processes that contribute to soil formation.
3. Describe how each of the processes occurs in nature.

Time: Completing all of the activities of this lesson will require approximately two 40-minute class periods.
Activity 1: Friction -- A Student Investigation

Time: Allow 14 minutes

Supplies needed for each group of four or five students:

* Two pieces of limestone (about 5cm x 5cm x 5cm)
* Two pieces of sandstone (about 5cm x 5cm x 5cm)
* Two pieces of paper towel
* One student activity sheet for each student

Supplies needed for use by the entire class:

* One quart-size jar labeled "soil particles."

Procedure:

1. Place the supplies listed above on the supply table.
2. Distribute to each student a student activity sheet.
3. Ask the students to read the Activity 1 section of the student activity sheet.
4. Ask the students if they have questions about what they are to do.
5. Direct the students to do Activity 1.

Activity 2: Chemical Change -- A Student Investigation

Time: Allow 8 minutes.

Supplies needed for each group of four or five students:

* One plastic or glass funnel
* One piece of filter paper to fit the funnel
* One hot plate
* Four or five pieces of limestone (2.5cm x 2.5cm x 2.5cm or smaller)
* About 5 ml of acetic acid (vinegar) in a container
labeled accordingly

* One baby food jar (any size)

**Supplies needed for use by the entire class:**

* The quart jar labeled "soil particles" used in Activity 1 including the soil particles added to it in Activity 1
* One spatula
* One forceps

**Procedure:**

1. Place the supplies on the supply table.
2. Be sure each student has retained the student activity sheet used in Activity 1.
3. Ask the student to read the Activity 2 section of the student activity sheet.
4. Ask the students if they have questions about what they are to do.
5. Direct the students to do the activity reminding them about the proper procedure for handling acids.
6. Ask the students to inform you when they have completed Procedure No. 6.
7. Ask the students to begin Procedure No. 7 and to continue to observe the limestone and acetic acid while doing Activity 3. Ask them to complete Procedures No. 8-11 at the end of the 10 minute period.
8. (optional) Repeating this activity using sandstone will demonstrate that all rocks are not broken
Activity 3: Wetting and Drying -- A Student Investigation

Time: Allow 10 minutes.

Supplies needed for each group of four or five students:

* One baby food jar containing moist topsoil for each student (It is important that the topsoil be just moist enough to be shaped into a ball.)
* Two pieces of paper towel for each student
* One shallow dish such as a 15cm diameter porcelain plate large enough to hold the soil in the baby food jar with the groups' identification numbers attached.

Procedure:

1. Place the supplies on the supply table.
2. Be sure each student has retained the student activity sheet from the previous activity.
3. Remind the students to continue to observe the limestone and acetic acid from Activity 2.
4. Ask the students to read the Activity 3 section of the student activity sheet.
5. Ask the students if they have questions about what they are to do.
6. Direct the students to do the activity.
7. When each group has completed the activity, ask one student from each group to place the dish of soil on the window sill.
Activity 4: Freezing -- A Student Investigation

Time: Allow 4 minutes the first day, 8 minutes the second day.

Supplies needed for each group of four or five students:

* One one-half gallon or two-liter paper (preferred) or plastic soft drink or juice container
* One piece of sandstone (about 2.5 cm x 2.5 cm x 2.5 cm)
* One knife or any cutting implement which the students can use to remove the bottom of the container

Supplies needed for use by the entire class:

* Storage space in the school freezer to freeze one container per group overnight

Procedure:

1. Place the supplies, except for the knife, on the supply table.
2. Write a different number on each bottle so the students will be able to distinguish among them later.
3. Be sure each student has retained the student activity sheet from the previous activity.
4. Ask the students to read the Activity 4 section of the student activity sheet.
5. Ask the students if they have questions about what they are to do.
6. Direct the students to do the activity.
7. After all of the groups have completed Procedure

-50-
No. 6 of the student activity sheet, select one student from each group to place his or her group's container in the school freezer. Make sure the containers are stored upright so the stones remain at the bottom of the container.

8. At the beginning of the class period on the next day select one student from each group to retrieve the containers from the school freezer.

9. Distribute to each group the knife or other cutting implement you've decided to have them use reviewing with them the proper technique for using it.

10. Ask the students to complete Activity 4 beginning with Procedure No. 7 of the student activity sheet.

Activity 5: Heating and Cooling -- A Student Investigation

Time: Allow 14 minutes (with optional activity allow 28 minutes)

Supplies needed for each group of four or five students:

* One hot plate
* One plastic or glass funnel
* One piece of filter paper to fit the funnel
* One tongs
* One shallow dish (of any material that will not burn)
* One bowl (about 15cm in diameter or larger)
* One pitcher of ice water in a quantity large enough to fill each group's bowl about three-
fourths full
* One piece each of limestone and sandstone (about 5cm x 5cm x 5cm) for each student

**Supplies needed for use by the entire class**
* The quart jar labeled "soil particles" used in Activities 1 and 2 including the soil particles added to it in those activities
* One spatula
* One forceps

**Procedure:**

1. Place the supplies listed above on the supply table.
2. Be sure all students have their activity sheets.
3. Ask the students to read the Activity 5 section on their activity sheets.
4. Ask the students if they have questions about what they are to do.
5. Direct the students to do Activity 5.
6. (Optional) Repeating the activity using limestone, will clarify to the students that the breaking down of rocks due to heating and cooling is not limited to sandstone, but holds true for other rocks as well.

**Activity 6: Weathering -- A Teacher-led Class Discussion**

**Time:** Allow minutes.

**Supplies:**
* The quart-size jar labeled "soil particles" used
in Activities 1, 2, and 5.

* A quart-size jar identical to the one above with approximately one inch of the topsoil used in Activity 3 inside, labeled "topsoil."

* One triple-beam balance

* One hand-held calculator

Procedure:

1. Lead a discussion relating what the students observed in the preceding activities to soil formation.

What natural processes contribute to soil formation?

* Friction, through glaciers and movement of rocks against each other as a result of freezing and thawing, as demonstrated by the students rubbing the two pieces of sandstone together in Activity 1.

* Freezing of water expands with tremendous force and when in cracks of rocks breaks the rocks into smaller pieces as demonstrated in Activity 4.

* Changes in temperature. Rocks are warmed by the sun during the day and cool during the evening. The rocks expand and contract which results in the chopping away of rock particles as demonstrated when the hot limestone was dropped into cold water in Activity 5.

* Wetting and drying (rainfall and lack of
rainfall) of soil itself perpetuates soil formation by changing the structure of the soil as demonstrated in Activity 3.

* Naturally-occuring acids break up rocks as demonstrated by the limestone in vinegar in Activity 2. The limestone, due to the action of the vinegar, releases carbon dioxide (the bubbles) as it breaks down into small pieces. A similar reaction occurs when plant roots take in oxygen from the soil air and give off carbon dioxide gas. The carbon dioxide dissolved in the soil moisture forming carbonic acid which acts on rock and other minerals in soil like the vinegar did on the limestone.

Is soil formation a rapid or slow process?

* Place the two jars on the demonstration table and state that (1) the one labeled "soil particles" is a collection of all the soil particles they created in the activities and (2) that the one labeled "topsoil" contains one inch of the topsoil they used in Activity 3.

* Tell the students that the demonstration will help them decide if soil formation is a fast or slow process.

* Ask a volunteer to determine the mass of the jar labeled "soil particles." Tell the students that you determined the mass of the jar without
the soil particles and found that it was _____ g. Record the mass of the jar alone on the chalkboard.

* Record the combined mass of the jar and soil particles on the chalkboard. Ask the students how the mass of the soil particles alone can be calculated knowing the data on the chalkboard.

* Ask a volunteer to do the calculation using the calculator and record the answer on the chalkboard.

* Ask a volunteer to determine the mass of the jar labeled "topsoil." Record its mass on the chalkboard.

* Tell the students that it took them approximately 40 minutes (not including the overnight freezing in Activity 4) to create the soil particles in the jar.

* Ask them how to determine how long it would take them to create enough soil particles to equal the mass of the one-inch of topsoil in the jar if they repeated the activities continuously. (Using a proportional calculation mass of soil particles = mass of topsoil

\[
\frac{40 \text{ minutes}}{x} = \frac{\text{mass of soil particles}}{\text{mass of topsoil}}
\]

then, solve for x,
\[
x = \frac{\text{(mass of topsoil) (40 minutes)}}{\text{mass of soil particles}}
\]

* Ask a volunteer to do the calculation using the calculator and record the answer (using "minutes" as the unit of measure) on the chalkboard. Show the students how to convert the answer to larger units of measure that might help them better conceptualize the amount of time it would take.

* Explain that although it might seem to take a long time for them to form that amount of soil particles, it would take even longer in nature because they exaggerated the soil formation processes in class. Friction does not occur as vigorously in nature as they might have rubbed the stones together, naturally occurring acids do not occur in the large amounts or in the concentrations they used, temperature changes are not as extreme as they subjected the stones to.

Student Activity Sheet

Lesson Number 1: Weathering

Objectives: By completing these activities you will be able to:

1. Decide if soil formation is a fast or a slow process.
2. Name three processes that contribute to soil formation.
3. Describe how each process occurs in nature.
Activity 1: Friction

Procedure:

1. Secure from the supply table two pieces of rock labeled "limestone," two pieces labeled "sandstone," and two pieces of paper towel.

2. Over one of the pieces of paper towel, gently rub two pieces of limestone together for about five seconds. Describe the material that collects on your paper towel.

3. Pick up some of the material from the paper towel between thumb and forefinger of one hand and rub those fingers together. Describe how the material feels to you.

4. Set aside the used paper towel and the limestone.

5. Over the other piece of paper towel, gently rub two pieces of sandstone together for about five seconds. Describe the material that collects on your paper towel.

6. Pick up some of the material from the paper towel between thumb and forefinger of one hand and rub those fingers together. Describe how the material feels to you.

7. Compare the limestone materials with the sandstone material and describe how they differ.
8. Name the force that is exerted anytime two objects are rubbing.

You applied this force to the rocks causing them to break into smaller pieces. Name two natural occurrences that might exert that force upon rocks to cause them to break into smaller pieces.

9. Pour the pieces of sandstone and limestone you scraped onto the paper towel into the jar on the supply table labeled "soil particles."

Activity 2: Chemical Change

Procedure:

1. Secure from the supply table one hot plate, four or five pieces of limestone, about 5ml of acetic acid, and one baby food jar.

2. Pour the acetic acid into the baby food jar and add to it the pieces of limestone. Observe the limestone for one minute and record any changes that occur in the limestone.

3. Place the baby food jar containing the acetic acid and limestone on the hot plate.

4. Plug the hot plate in and set the temperature setting to medium.

5. Observe and record any changes you observe in the limestone over a period of five minutes.
6. If you observe bubbles being generated in the acetic acid, determine where the bubbles are coming from and record your observation here.

7. Continue to heat the acetic acid and limestone while you do Activity 3 occasionally recording further changes you observe.

8. After you've completed Activity 3, turn the hot plate off and disconnect it. If you observe an accumulation of material on the bottom of the jar, discuss among your group where that material might have come from and record what you think is the best answer.

If no material accumulated on the bottom of the jar, record that observation.

9. As a group list some natural sources of acids such as acetic acid that might react similarly with rock.

10. Filter any soil particles that may have formed from the acetic acid by pouring the acid through the filter and funnel into the sink.

11. Scrape the soil particles from the filter paper into the jar on the supply table labeled "soil particles" using the spatula and forceps provided there.

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Activity 3: Wetting and Drying

Procedure:

1. Secure from the supply table a baby food jar full of soil, one shallow dish, and two pieces of paper towel.

2. Carefully dump the soil out of the jar onto a piece of paper towel.

3. Take the soil and squeeze it together in your hands to make a firm ball, then place it on the same piece of paper towel. Wipe your hands with the other piece of paper towel.

4. Fill your baby food jar about one-half full of water.

5. Carefully place your ball of soil into the water in the jar.

6. Record changes you observe in your ball of soil over a period of about one minute.

7. As a group, discuss what might have caused the changes you observed in the ball of soil and list what you think are the best answers.

8. Pour off into the sink as much of the water from the jar as possible without pouring out the soil. Pour the soil and any remaining water out of the jar onto the shallow dish. Record your dish number here. Dish number _______.
9. Describe the soil using the following terms and phrases that are applicable and other terms or phrases of your choice: shiny, dull, dark in color, light in color, hard, soft.

10. Place the dish on the window sill for two days. Then once again describe the soil using terms and phrases similar to those you used to describe the soil in Procedure No. 9.

11. As a group, discuss what might have caused the changes you observed in the soil over the two-day period and list what you think are the probable causes.

12. Describe what effect rain and or lack of rain might have on soil in nature.

Activity 4: Freezing

Procedure:

1. Secure from the supply table one plastic container, one piece of sandstone, and one piece of limestone.

2. Carefully observe for about one minute, each of the pieces of sandstone and limestone noting below its shape, size and position of cracks, etc. Sketch the stones below.
3. Gently place the pieces of limestone and sandstone into the plastic container.

4. Fill the plastic container completely to the top with water and put the cap on. Record the number written on the container here. 

5. Return the container to the supply table. It will be placed in the school freezer overnight. Tomorrow you will observe it to see if it, or the sandstone and limestone, changed in any way.

6. Predict what changes you expect to observe tomorrow.

7. Describe how the container has changed since the water has frozen.

8. Set the dish containing the sandstones on the

9. Using the knife, carefully cut the bottom out of the container to expose the sandstone and limestone.

10. Describe changes that occurred in the limestone and sandstone since the water in and around them was frozen.

11. Explain, based on your knowledge and observations of water when it freezes, what caused the changes you observed in the container and sandstone and limestone.

12. Describe situations in nature where freezing water contributes to soil formation.
Activity 5: Heating and Cooling

Procedure:

1. Secure from the supply table one hot plate, one tongs, one shallow dish, two pieces of paper towel, one piece of filter paper, one funnel, and one bowl.

2. Fill the bowl about three fourths full of ice water from the pitcher at the supply table.

3. Observe carefully for about one minute your pieces of sandstone noting in your mind its shape, the size and position of cracks, etc. Get to know your sandstone! Then place it in the shallow dish along with the sandstone of the others in your group.

4. Set the dish containing the sandstones on the hot plate.

5. Plug in the hot plate and turn the temperature setting to low and heat the sandstones for about five minutes.

6. While waiting for your sandstone to warm, predict what you would expect to happen if you took the heated sandstone out of the dish and placed it into the ice water.

7. After the sandstones have been warmed for about five minutes, pick up the sandstone using the tongs and immediately immerse it into the ice water for about five seconds while holding it
with the tongs.

8. Remove it from the ice water and place it on one of your pieces of paper towel.

9. List changes you observe in the sandstone since you observed it in Procedure No. 3. 

10. Share your observations with your group after everyone has immersed their sandstones in the ice water.

11. Describe what you see in the ice water that was not there before you immersed your sandstone in it. 

12. Name the characteristic of the sandstone that you changed by heating it on the hot plate and by cooling it in the ice water. 

Name a natural occurrence that can also heat rock and soil. 

13. Using the filter paper and funnel, separate the soil particles from the water in your bowl by pouring the water through the filter into the sink.

14. Scrape the soil particles from the filter paper into the jar labeled "soil particles" at the supply table using the spatula and forceps provided there.

15. Return all of your supplies, except the hot plate, to the supply table and dispose of your
paper towel. Put the hot plate in the center of your table to cool.

Teacher's Guide

Lesson Number 1: Using Land Within Its Limitations

Rationale: Soil properties and characteristics limit the suitability of land for particular uses. Some limitations can be overcome through the use of erosion control measures or by taking special precautions—most of which require expenditure of money and resources. If the limitations are ignored and the land is used for purposes for which it is unsuited, severe soil erosion, loss of human lives, destruction of property, and other catastrophes may occur.

Soil survey reports describe soil limitations and are available for every county in Iowa and nearly every county in the United States. Although free for use by anyone, very few people use them.

This lesson will make students aware of potential problems that may result from the misuse of land, help them understand how erosion can be controlled, and teach them how to use a soil survey report.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. Land is often misused by humans.
2. Soil erosion results from some misuse of land.
3. Using land for uses for which it is unsuitable is a misuse of land.
CHAPTER 4
Land Use and Misuse
Teacher's Guide

Lesson Number 1: Using Land Within Its Limitations

Rationale: Soil properties and characteristics limit the suitability of land for particular uses. Some limitations can be overcome through the use of erosion control measures or by taking special precautions—most of which require expenditure of money and resources. If the limitations are ignored and the land is used for purposes for which it is unsuited, severe soil erosion, loss of human lives, destruction of property, and other catastrophes may occur.

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This lesson will make students aware of potential problems that may result from the misuse of land, help them understand how erosion can be controlled, and teach them how to use a soil survey report.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. Land is often misused by humans.
2. Soil erosion results from some misuses of land.
3. Using land for uses for which it is unsuitable is a misuse of land.
4. Soil erosion can be reduced by applying soil conservation measures to the land.

5. Soil survey reports can help people determine for what uses land is most suitable.

Process Objectives: At the end of this lesson each student will be able to:

1. List ways that land is misused by humans.
2. Describe how soil erosion can be controlled.
3. Assess the suitability of a given area of land for a particular use by using a soil survey report.

Time: Allow four 40-minute class periods to complete the following activities.

Activity 1: Misuses of Soil -- A Filmstrip

Time: Allow 20 minutes with discussion.

Supplies:

* The sound film strips "Soil: Its Meaning for Man," (set of two). Only filmstrip No. 2 will be used in this activity. Filmstrip No. 1 was used in Chapter 1. Available from Vocational Media Associates, Box 3000, Mt. Kisco, NY 10549; purchase price, $79 with program guide.

Procedure:

1. Introduce filmstrip No. 2 by reviewing that:
   a. Humans are dependent upon soils for their well-being.
   b. Some soils are more suitable for some uses than others.
c. Soils are often used for purposes for which they are not suitable.

This filmstrip will analyze a variety of misuses of soil.

2. Show the filmstrip.

3. Focus discussion, using the filmstrip program guide, on misuses of soil on cropland, at construction sites, mined land reclamation, rangeland, and landscaping.

Activity 2: Soil Erosion and Erosion Control Measures

Time: Allow 60 minutes.

Supplies needed per class:

* Seven shoe boxes of equal size

* Seven cutting devices (scissors large enough to easily cut shoe boxes are preferred)

* Enough plastic sheets or plastic garbage bags to cover the bottom 10cm of the inside of each shoe box

* Seven identical plastic containers with bases no greater than 12.5cm in diameter and no less than 7.5cm in diameter (whipped topping or margarine containers are good for this use)

* Seven identical quart glass jars

* Enough moist (not waterlogged) topsoil to fill the boxes to a depth of 5cm

* Seven small scissors

* Source of water (about seven liters)
* Eight 30.5cm metric rulers
* One strip of sod large enough to fill one of the shoe boxes to a depth of 5cm
* Seven yardsticks or meter sticks
* Seven pressure sensitive labels
* One stopwatch
* Dry grass clippings (enough to cover the bottom of one of the shoe boxes 2.5cm deep)
* One black felt-tip marker
* One graduated cylinder
* Seven quart-size or larger glass jars or plastic containers
* Seven nails (6 penny or 5cm in length)
* Seven 13cm x 20cm index cards or equal-size poster board
* Two eight-foot or ten-foot 2in. x 4in. boards
* Directions for preparing soil demonstration plot boxes (seven copies)
* Directions for constructing soil demonstration plots (seven copies)
* One 15cm ruler

Procedure:

1. Prepare the following direction sheets for later distribution at three work stations before conducting the activity.

2. Title: "Directions for Preparing Soil Demonstration Plot Boxes"
a. Secure from the supplies at this station one shoe box, one scissors (or other cutting device), and one ruler. You will need your own pencil.

b. Draw a straight line around the outside of the box 5cm above the bottom of the box.

c. Cut along the line all the way around the box using the scissors.

d. Discard the top portion of the box. The bottom of the box is your soil demonstration plot box.

e. Cut a "V"-shaped notch at one end of the box following these directions:

   * Measure the length of the end of the box and divide that distance by 2. Your answer is the midpoint of the length.

   * Draw with your pencil at the midpoint a straight line from the top of the box to the bottom.

   * Measure 1.3cm up from the bottom of the box along the midpoint line and label the point "A".

   * Measure and mark a distance of 2.5cm from both sides of the midpoint line where it meets the top of the box. Label one of the points "B" and the other "C".

   * Draw a straight line from point "A" to point "B".

   * Draw a straight line from point "A" to point "C".

   * Measure the lengths of lines "AB" and "AC".
Both lengths should be about 4.5cm. The distance from point "B" to point "C" should be 5cm. If your measurements are different than that, consult your teacher.

* Cut along lines "AB" and "AC". Remove and discard the triangle-shaped piece.

* You have completed the preparation of the soil demonstration plot box.

* Take the box to the demonstration station.

3. Title: "Directions for Constructing a Rain Simulator"

a. Secure from the supplies at the station one plastic container and one nail.

b. Punch holes in the bottom of the container from the inside out using the nail, duplicating as closely as possible the hole-pattern below. The result will be your rain simulator.

![Hole Pattern for Rain Simulator](image)

c. Secure from the supplies at the station one glass or plastic container.

d. Measure exactly 800ml of water using the graduated cylinder and pour it into the container.

e. Take your container of water and your rain simulator to the demonstration station.
4. Title: "Directions for Preparing Soil Demonstration Plots"

a. Secure from the supplies at the station one 13cm x 20cm card.

b. Write your group number about 3cm tall in the upper left of the card using the felt-tip marker at your station.

c. Write as large as possible on the card the title of the soil demonstration plot below assigned to your group.
   Group 1: Trail
   Group 2: Sod
   Group 3: Contour Tillage
   Group 4: Straight Tillage
   Group 5: Sediment Basin
   Group 6: Loose Soil
   Group 7: Mulched Soil

d. Secure from the supplies one glass jar, and one label. Write the title of your soil demonstration plot on the label and stick it on your jar.

e. Secure from the supplies one scissors, one sheet of plastic, and one yard stick or meter stick.

f. Cut a rectangle ___cm x ___cm out† of the sheet of plastic. (Note to teachers: The dimensions above should be 20cm wider and 20cm longer than the surface dimensions of the shoe boxes.)
g. Gather the materials brought to you by members of your group from other stations with your sheet of plastic, sign, and glass jar.

h. Lay over the soil demonstration plot box, when you receive it, the sheet of plastic leaving about 10cm hang over each side and end of the box.

i. Do the following according to your group's number:

Group 1: Fill the soil demonstration plot box with soil and pack down the soil firmly with your hands.

Group 2: Fill the soil demonstration plot box with sod. If the top of the soil is not even with the top of the box, add enough soil to make it so. Trim the grass with the scissors until it is about 3cm long.

Group 3: Fill the soil demonstration plot box with soil. Make three or four furrows packed down about 1.5cm deep in the soil with your finger from one side of the box to the other.

Group 4: Fill the soil demonstration plot box with soil. Make two or three furrows packed down about 1.5cm in the soil with your finger from one end of the box to the other.

Group 5: Fill the soil demonstration plot box with soil. Pack down the soil with your hand
to create a small pond (basin) about 2.5cm deep and 10cm in diameter, the center of which should be about 10cm from the end of the plot with the "V"-shaped notch.

Group 6: Fill the soil demonstration plot box with soil. Do not pack down the soil.

Group 7: Fill the soil demonstration plot box with soil. Pile grass clippings evenly about 1.5cm deep on the soil surface.

j. Place your title card between the soil and the box at the end of the box opposite the "V"-shaped notch and facing the notch.

k. Your soil demonstration plot is now completed.

5. Distribute to each student the student activity sheets.

6. Explain to the students that you will divide the class into seven groups and that each group will construct a different soil demonstration plot. Each group will be subdivided into four smaller groups; one to prepare the soil demonstration plot box, one to construct a rain simulator, one to prepare the soil demonstration plot, and one to conduct the demonstration.

The demonstration will show the effectiveness of a variety of soil erosion control measures and provide insight into what combinations of erosion control measures might be even more effective.
7. Ask the students to read the activity sheets.
8. Ask if the students have questions about what they are to do.
9. Divide the class into seven groups, then subdivide each group into four smaller groups as described in Procedure No. 6 and direct them to their respective work stations. Those assigned to conduct the demonstration may observe or assist other subgroups within their own groups.
10. Ask the students to carry out the instructions listed at each work station.
11. Ask those who are to conduct the demonstrations to bring their group's soil demonstration plot, rain simulator, and water supply to the demonstration area. There should be two or three students per group to conduct the demonstration.
12. Ask the demonstrators to line up their soil demonstration plots on an incline. One way to do this is to place the two 2in. x 4in. boards on top of each other on a table. The back of each plot (the end opposite the "V"-shaped notch) should be on the 2in. x 4in. boards with the end with the notch at the edge of the table.
13. Instruct the demonstrators that one (or two) students from each group should hold the rain simulator 30cm above the elevated end of their plots and simultaneously pour their entire water
supply into their simulators on your signal. Another student from each group should hold a jar (the jars must be identical to each other) under the "V"-shaped notch at the other end of the plot to catch water and soil that might run off the plots.

14. Start your stopwatch when you give the demonstrators the signal to begin and instruct the other students to record in Table 1 on their activity sheets how long water flows off of each plot as you call off the times. For example: "Trail plot, 15 seconds...Straight Tillage plot, 17 seconds," etc.

15. Give the signal to begin the demonstration.

16. Ask one member from each group to measure the depth of the water in their jars and report their findings to the other groups to record in Table 1 on their activity sheets.

17. Ask the students to display the soil demonstration plots and glass jars in an area where they can be examined later by students.

18. Ask one member from each group the next day to measure the depth of soil in their glass jars and to report their findings to the other groups to record in Table 1 on their activity sheets.

19. Ask the students to complete the activity sheets.

20. Discuss as a class students' conclusions.
Activity 3: Wind Erosion and Control

Time: Allow 40 minutes.

Supplies needed for each group:

* One cardboard box approximately 46cm x 60cm cut down to a height of about 5cm and lined with a plastic sheet or garbage bag
* One multi-speed electric fan
* Enough sand (coarse, fine, and small gravels) to fill the box
* Ten tongue depressors cut in half (or 20 pieces of poster board about 2.5cm x 10cm)
* Student activity sheets for each student
* At least one hand lens (preferably one per student)

Procedure:

1. Fill the plastic-lined boxes with sand to within about 1.5cm of the top.
2. Place at each group's table one fan, one box of sand, the tongue depressors, and student activity sheets for each student.
3. Position each fan at a distance from the box and set each at a velocity so the wind created will move the sand in the box at a moderate speed.
4. Explain to the students that this investigation will demonstrate wind erosion and will give them the opportunity to determine ways of preventing wind erosion.
5. Ask the students to read the activity sheet.
6. Ask the students if they have questions about what they are to do.

7. Direct the students to do the activity.

8. Ask each group to demonstrate to the class the most effective method they devised to control wind erosion.

9. Ask the students if wind erosion is a problem limited to sandy soils. (Because of the relatively large size of sand particles, most are never airborne, but creep along the surface and eventually form large visible sand dunes. Silt and clay particles are much smaller and are more easily borne in the air and dispersed widely and far from where they left the soil surface. Therefore, wind erosion of silt and clay particles is generally less apparent. Actually, wind erosion of silt and clay particles is greater than that of sand and is generally the precursor of wind erosion of sand.

10. Ask the students in what kind of landscape wind erosion might occur most easily. (flat, undisturbed, bare land)

11. Ask the students what people could do to prevent wind erosion on such land.

Activity 4: Mass Movement -- A Teacher Demonstration

Time: Allow 20 minutes

Supplies:

* One cardboard box approximately 46cm x 60cm

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to a height of about 5 cm and lined with a plastic sheet or garbage bag (same as used in Activity 3)

* Enough sand (fine, coarse, and small gravels) to fill the box (same as used in Activity 3)

* One rain simulator (as described in Procedure 3 of Activity 2)

* Twenty toothpicks

* One protractor

* One tongue depressor cut in half

* Approximately one liter of water

Procedure:

1. Fill the box with sand before doing the demonstration.

2. Form the sand in the box into a cone shape with sides as steep as possible to begin the demonstration. While shaping the sand ask the students to name the force that prohibits you from shaping sides of the cone perpendicular to the bottom of the box. (gravity)

3. Ask the students, after you have completed shaping the sand, if gravity is still exerting a force on the sand even through the sand is not moving.

4. Explain to the students that you will demonstrate "mass movement" of soil, the result of gravity acting on soil. Mass movement is a common, though often a very slow, process on land having steep slopes.
5. Stick the toothpicks about 1.5cm deep into the sand perpendicular to the sand surface using a protractor to ensure accuracy. Distribute the toothpicks evenly around the portion of the cone which is visible to the students.

6. Ask a student to check the accuracy of your placement of some of the toothpicks.

7. Ask the students what effect mass movement might have on the position of the toothpicks. (They will no longer be perpendicular to the sand surface, they will move down slope)

8. Explain to the students that if the cone was left undisturbed for several weeks mass movement of the sand would be detectable by checking the positions of the toothpicks.

9. Ask the students to suggest ways that the rate of mass movement can be increased so it can be demonstrated within the next few minutes, based on their experiences of playing with sand and their knowledge of how natural physical forces affect soil particles. (mechanically disturb the sand, add water, freezing, thawing, wind, earthquake)

10. Ask the students to describe what effect each of those forces have on individual soil particles. (they move soil particles)

11. Demonstrate mechanical disturbance by presenting
students with this analogy. The sand cone represents a hillside upon which a family wants to build a house. To do that, the soil surface where the house is to be located must be disturbed--leveled. State that you will do that with the tongue depressor representing earth moving equipment.

12. Ask the students to predict what effect soil surface disturbance might have on soil nearby.

13. Level a portion of the cone surface using the flat end of the tongue depressor held perpendicular to the table surface and about 2.5 cm downslope and 2.5 cm to one side of one of the toothpicks.

14. Ask a student to measure the angle of the toothpick nearest your disturbance to determine if mass movement occurred at that point. (Ask the student to check other toothpicks if it is apparent mass movement was more widespread)

15. Demonstrate the effect of water on the rate of mass movement. Use the rain simulator to slowly add water to the sand. Ask the students to watch the toothpicks carefully to detect early signs of mass movement. Eventually, relatively large sand slides will occur as the sand becomes saturated.

16. Ask the students where they have heard of great landslides or mudslides occurring and what kinds of destruction resulted.

17. Ask the students what could be done to prevent the
destruction caused by catastrophic mass movement. (constructing buildings and transportation routes on soils with slopes and soils susceptible to catastrophic mass movement is a misuse of that land and should be avoided)

Activity 5: Determining Soil Suitabilities -- A Small Group Investigation

Time: Allow 40 minutes.

Supplies needed for each group of two or three students:

* Soil survey report for your geographic area
* Student activity sheet for each student

Procedure:

1. Acquire free copies of the soil survey report for your geographic area from the local office of the United States Department of Agriculture -- Soil Conservation Service. The address and phone number can be found in the Government section of your telephone directory.

2. Ask Soil Conservation Service personnel to help you locate the soil map sheet in the back of the report that shows the location of your school. (You can locate the map yourself by using the Index to Map Sheets at the beginning of the maps section in the back of the soil survey report. Find the general location of you school on the map and turn to the map sheet number associated with your location. Look on the map for landmarks that exist
near your school to help you locate the school.)

3. Make an overhead transparency of that map for use in class to help the students locate the school on their own map sheets.

4. Familiarize yourself with the map symbols on the area of the map around your school. A legend that describes symbols can be found on the back of the Index to Map Sheets.

5. Complete the student activity sheet yourself if you're not familiar with the use of soil survey reports.

6. Distribute soil survey reports and student activity sheets to each group.

7. Ask the students to read the activity sheets.

8. Ask the students if they have questions about what they are to do.

9. Direct the students to begin the activity sheet. Use the overhead transparency of the map sheet to help the students locate the school.

10. Ask the students after they have completed the activity sheet:

   a. Do you think it was a good decision to build the school where it is, based on the limitation of the soil and on the productivity of the soil for agricultural use?

   b. What other considerations might have affected the decision to build the school here?
11. (Optional) Ask the students to:
   a. Determine if their own houses or apartments
      were built on soils suitable for that use.
   b. Determine if a new housing development is being
      or was built on soils suitable for that use.
   c. Invite a developer to speak to the class
      about how he or she uses soils information to
      determine where to construct housing or building
      developments and how he or she overcomes soils
      limitations to such developments.

Student Activity Sheet

Lesson Number 1

Objectives: By completing the following activities you
will be able to:

1. List ways land is misused by humans.
2. Describe how soil erosion can be controlled.
3. Assess the suitability of a given area of land for
   a particular use by using soil survey reports.

Activity 2: Soil Erosion and Erosion Control Measures

Procedure:

1. Write here the number of the group to which
   your teacher assigned you. Group number _____.
2. Go to the work stations assigned to you
   by your teacher.
3. Read the instruction sheet at your work
   station. If you are not sure what you are to do
   at the station, discuss questions you have about

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the instructions with other students at your work station. If you and the other students are not sure what you are to do, consult your teacher.

4. Carry out the instructions.

5. Go to the demonstration area.

6. Complete Table 3 below during and following the demonstration.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Time (sec)</th>
<th>Depth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLOT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Eroded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight Tillage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contour Tillage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loose Soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mulched Soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sediment Basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sod</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3. Surface runoff data from demonstration plots.

<table>
<thead>
<tr>
<th>PLOT</th>
<th>DURATION OF WATER FLOW</th>
<th>AMOUNT OF RUNOFF</th>
<th>AMOUNT OF SOIL ERODED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Straight Tillage</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Contour Tillage</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Loose Soil</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Mulched Soil</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Sediment Basin</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Sod</td>
<td>sec.</td>
<td>cm</td>
<td>cm</td>
</tr>
</tbody>
</table>

10. Name the plot that retained the most water.

11. Describe the relationship between the amount of runoff from a soil plot and the amount of soil eroded from the same plot.

12. Name the soil erosion control measures that were the most effective.

13. Select three plots as examples and describe what you think accounts for the differences in the amounts of soil eroded from each.

14. Name soil erosion control measures that might be more effective if combined with the above measures.

### Activity 2: Wind Erosion and Control

**Procedure:**

1. Turn the fan on at the velocity indicated by your teacher.
7. Name the plot that lost the most soil.

8. Name the plot that retained the least water.

9. Name the plot that lost the least soil.

10. Name the plot that retained the most water.

11. Describe the relationship between the amount of runoff from a soil plot and the amount of soil eroded from the same plot.

12. Name the soil erosion control measures that were the most effective.

13. Select three plots as examples and describe what you think accounts for the differences in the amounts of soil eroded from each.

14. Name soil erosion control measures that might be more effective if combined.

Activity 3: Wind Erosion and Control

Procedure:

1. Turn the fan on at the velocity indicated by your teacher.
2. Observe the movement of the different sizes of sand soil particles in your wind erosion simulator for about five minutes.

* Name the particle size that seems to move the most (fine, coarse, small gravels).

* Describe where fine sand particles tend to accumulate and what you think causes them to accumulate there.

3. Turn the fan off and redistribute the sand evenly throughout the box.

4. Stick two tongue depressors hereafter referred to as wind obstructors, in the sand rounded end up about 5cm apart in the middle of the box one with a flat side facing the fan (label "A") and the other with the flat side facing the sides of the box (label "B").

5. Turn the fan on at the same velocity used before.

6. Observe the movement of sand particles around the wind obstructors for about five minutes.

* Describe what happens to the sand on the windward side (the side facing the wind) of the wind obstructors "A" and "B".

"A"

"B"
Describe what happens to the sand on the leeward side (side away from the wind) of wind obstructions "A" and "B".

"A"

Decide which of the wind obstructions does the best job of obstructing the wind and explain your decision.

"B"

* Describe how the effects of wind obstructions "A" and "B" differ.

* Decide which of the wind obstructions does the best job of obstructing the wind and explain your decision.

7. Turn the fan off, remove the wind obstructions, and redistribute the sand evenly throughout the box.

8. Lay two wind obstructions flat on the sand surface about 5cm apart in the middle of the box one parallel to sides of the box (label "A") and the other perpendicular to the sides of the box (label "B").

9. Turn the fan on at the same velocity used before.

10. Observe the movement of sand particles around the wind obstructions for about five minutes.

* Describe what happens to the sand around and under wind obstructions "A" and "B".

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2. Write the name of the soil zone which delineated on the property map.

3. Write the name of a different soil zone that is delineated on the property map.

* Decide which of the wind obstructors does the best job of obstructing the wind and explain your decision.

11. Turn the fan off, remove the wind obstructors, and redistribute the sand evenly throughout the box.

12. Devise two methods of controlling wind erosion using the wind obstructors at your table and decide which of them is most effective in controlling wind erosion. Discuss the relative merits of each method before you actually try it and determine how you will decide which method is most effective.

13. Test each method you devise for about three minutes in your wind erosion simulator.

14. Demonstrate your most effective wind erosion control method to the class.

Activity 5: Determining Soil Suitabilities

Procedure:

1. Find the location of your school on map sheet number _____ in the back of the soil survey report. (Note to teachers: Indicate in the blank -90-
2. Write here the map symbol for the soil upon which the school is located. Different soils are delineated on the map much the same as a color-by-number picture. The location of a particular kind of soil is delineated by a continuous line within which is a symbol (usually a number alone, but sometimes including a letter) that indicates what kind of soil it is.

3. Locate near the front of the map section of the soil survey report the Soil Legend. It lists all soil symbols in numerical order and the names of associated soils. Locate the map symbol from Procedure No. 2 above on the Soil Legend and write here the name of the soil upon which your school is located.

4. Find the Contents page in the soil survey report. Find within the Contents the heading "Use and management of the soils," and within that heading, the subheading "Engineering." Turn to the page in the soil survey report where you will find information about engineering.

5. Read the introduction section about engineering and the section "Building Site Development." Pay particular attention to the subsection "Dwellings and small commercial buildings."

6. Name here the number of the table in the soil survey
report that shows the degree and kind of soil limitations that affect small commercial buildings (your school). Table _____.

7. Find that Table in the soil survey report by locating the Tables heading in the Contents page.

8. Turn to that Table and find in the Table the map symbol for the soil upon which your school is located. Soil symbols are listed in numerical order in the "Soil name and map symbol" column.

9. Locate on the Table the column "Small commercial buildings" and follow down the column until you reach the same level as your map symbol. Write here the limitations for constructing small commercial buildings on the soil on which your school is located as stated in the Table. ________________

10. Decide, based on the limitations of the soil, if the decision to build the school on this soil was a good one. Explain your decision. Use the Glossary in the soil survey report and review the section of the report you read in Procedure No. 5 for help.

11. Locate in the Tables section of the soil survey report a Table that reports yields per acre of crops. State here the expected yield of corn per acre for the soil upon which your school was built.

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bushels per acre.

12. Compare the yield of corn per acre from Procedure No. 11 with yields of corn for other soils listed in the Table. State here whether or not the land upon which your school was built was once, in your judgement excellent, good, or poor cropland for corn and justify your answer.

13. State here, based on your findings in Procedures No. 10 and 12, whether you think it was a good decision to build the school where it is now or if it might have been better to use it as cropland. Justify your decision.

14. List here possible reasons the school was built where it is other than soil-related reasons.
CHAPTER 5
Soil and Water Conservation Issues
Teacher's Guide

Lesson Number 1:

Rationale: Two soil and water conservation issues that have been debated for decades are:

1. Should erosion control be voluntary or mandatory?
2. Who should pay for erosion control costs?

The debate has resulted in significant changes in soil and water conservation laws in just the past three years. The issues remain unresolved.

In this activity students will determine other's views about those issues, will formulate their own opinions about them, express their opinions to the class as part of a public hearing which they will conduct regarding a fictitious but realistic soil and water conservation bill that deals with the issues.

Laws are an important tool in natural resource management at all levels of government. Such laws are established by elected officials as a result of concerns expressed by the people the elected officials represent. Concerns are often expressed through public hearings. The following activity will give students an idea of what public hearings are like and also give them a chance to make value judgements based on their understanding of soil and water conservation and testimony presented at the hearing. They will discover that there are at least
two sides to most questions and that there are seldom easy answers to soil and water conservation issues.

Knowledge Objectives: At the end of this lesson, each student should know that:

1. There are many different opinions about how best to control soil erosion.
2. Seldom are there easy solutions to soil and water conservation issues.
3. Public hearings give citizens opportunities to express their opinions to government officials about how soil resources are to be used.

Process Objectives: At the end of this lesson each student will be able to:

1. Cite examples of differing opinions about soil and water conservation issues.
2. Express their own opinions about soil and water conservation issues.
3. Describe a public hearing and how it is conducted.

Time: Allow one 40-minute class period.

Activity 1: Soil and Water Conservation Issues

Time: Allow one 40-minute class period.

Supplies:

* Student activity sheets for each student

Procedure:

1. Distribute the student activity sheets to the students.
2. Explain to the students that in this activity
they will discuss and formulate their own opinions about soil and water conservation issues.

3. Ask the students to read the student activity sheet.

4. Ask the students if they have questions about what they are to do.

5. Ask the students, over the next two nights, to interview at least three adults to get their opinions about the questions on the activity sheet.

6. Ask the students during the class period following the second night to conduct a public hearing according to the following procedure.

7. Ask three or five students to serve as a conservation committee. One student should serve as chairperson of the committee. The committee will conduct the public hearing and will recommend to the class, based on testimony presented by the students, either approval or disapproval of the soil and water conservation bill.

8. Allow each student no more than one minute to express his or her opinion of the bill to the committee. Committee members only are allowed to ask questions of clarification of the student testifying.

9. Ask the committee to openly discuss the opinions presented by the students for no more than five
minutes and to decide whether to recommend to the class approval or disapproval of the bill.

10. Ask each student, following the announcement of the committee's decision, to vote (by show of hands or by secret ballot) in favor of or in opposition to the committee's decision.

11. State, if the class vote disapproves the committee's recommendation, that such committees on occasion misrepresent the opinions of the public in real life. Discuss possible reasons why this might occur.

12. If time permits discuss changes that should be made in the bill, if it was disapproved by either the committee or the class, that might make it passable.

13. Explain to the students that although the bill they debated was fictitious, each element in the bill is actually a part of some current federal or state laws and county or municipal ordinances.

Student Activity Sheet

Lesson Number 1:

Objectives: By completing this activity you will be able to:

1. Cite examples of differing opinions about soil and water conservation issues.

2. Express your own opinions about soil and water conservation issues.
3. Describe a public hearing and how it's conducted.

Procedure:

1. Gather opinions that others have about how soil erosion can best be controlled by interviewing at least three adults (one only from your immediate family) following the directions in Part I of this activity sheet.

2. Read the "Soil and Water Conservation Bill" in Part II of this activity sheet.

3. Write answers to each question in Part II.

4. Read Part III and follow the directions.

Part I: Soil and Water Conservation Interviews

1. Ask three adults (one only from your immediate family) if you can interview them for about 20 minutes about soil and water conservation issues.

2. Read to each person the following "FACTS" about soil erosion.

**FACTS**

* In the time it takes us to do this interview (about 20 minutes) America will lose nearly 228 million tons of its most productive topsoil to wind and water erosion; enough soil, each day, to fill a train more than 700 miles long; six billion tons a year.

* On some land, soil is being lost two to four times faster than nature can replace it.

* Losses from farmland exceed three billion tons per year.

* While erosion diminishes the productivity of the land,
it also results in sedimentation of rivers, lakes, road
ditches, and reservoirs.

* Sediment in our reservoirs causes a daily depletion of
reservoir capacity equaling six 8-ounce glasses of water
for every man, woman, and child in America.

* Estimated damages directly related to sediment is
$3 billion per year about $1 billion of which is attributed
to cropland erosion.

3. Ask each person the following "QUESTIONS" and
record their answers on separate paper.

QUESTIONS

1. Who do you think should pay the costs of controlling
soil erosion on farmland?
   a. farmers
   b. the public through county government
   c. the public through state government
   d. the public through federal government
   e. a combination of all of the above

2. Please state and explain your reasons.

3. Do you think farmers should control erosion on their
lands
   a. on a voluntary basis?
   b. on a mandatory basis?
   c. on a mandatory basis if they wish to be eligible to
   receive government support payments, reduced interest
   rates on loans, and other government benefits?

4. Please state and explain your reasons.
5. In a program called the Conservation Reserve Program, some farmers no longer grow crops on some highly erodible land they once farmed and, in return for doing so over a ten year period, are receiving payments from the federal government equal to what the farmers would receive if they farmed the land and sold the crops. Do you think that is a good idea? Please state and explain your reasons.

6. Who do you think should pay the costs of controlling soil erosion on lands disturbed for housing or business developments?
   a. the developers?
   b. the public through city government?
   c. the public through county government?
   d. the public through state government?
   e. the public through federal government?
   f. a combination of all of those choices?

7. Please state and explain your reasons.

8. Do you think developers should control erosion on lands they disturb on a voluntary basis?
   a. on a voluntary basis?
   b. on a mandatory basis?
   c. on a mandatory basis to be eligible to receive government grants or loans at reduced rates?

9. Please state and explain your reasons.

   PART II: Soil and Water Conservation Bill

Following is an example of what a potential law or bill
about soil conservation might look like. In Part III the class will determine if it is a good bill through a process called a public hearing. Read the bill and write your answers to the questions on separate paper.

SOIL AND WATER CONSERVATION BILL

Article I. Erosion Control by Farmers

Section 1. It shall be mandatory for farmers to control soil erosion on their own land in order to be eligible to receive government support payments, reduced interest rates on government loans, and other government benefits.

Section 2. Farmers who do not control soil erosion on their own land shall not be eligible to receive government support payments, reduced interest rates on government loans, and other government benefits.

Section 3. Farmers who do not control soil erosion on their own lands shall not be fined nor will they be imprisoned for that reason.

Article II. Cost of Erosion Control on Farmland

Section 1. County, state, and federal governments shall share with farmers the cost for controlling erosion on farmland.

Section 2. Farmers shall be paid by the federal government for not growing crops on highly erodible cropland for a period of ten years. The amount paid will be equal to what the farmers would have received if they had farmed the land and sold the crops.

Article III. Erosion Control by Developers and Costs of Control
Section 1. It shall be mandatory for developers of land for housing or business to control erosion on land they disturb.

Section 2. Developers who do not control erosion on land they disturb will be fined an amount double in value of that estimated by the county government that would have been needed to control the erosion.

Section 3. The cost of controlling erosion on lands disturbed for housing or business development shall be borne by the developer.

Write for each section of the Soil and Water Conservation Bill on a separate sheet of paper whether or not you agree with the section and explain your reasons. You will be asked to express orally to the class your opinions and reasons in Part III of this activity.

PART III: Soil and Water Conservation Public Hearing

Before a legislative bill or ordinance is voted on by a governing body, people are given the opportunity through a public hearing to express their opinions about the bill so the members of the governing body can find out what the people like and dislike about the bill.

Your class will vote on the Soil and Water Conservation bill, but before doing so, the class will conduct and participate in a public hearing. You and every other student will be asked to express orally your opinions about the bill in a time frame of between 30 and 60 seconds.

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Rewrite your opinions from Part II of this activity sheet in such a way that when you read it in class you will persuade other students to agree with you. Remember, your presentation should take between 30 and 60 seconds.