Curriculum Embedded Performance Task
Middle School Science
Content Standard 6.1, 6.2 or 6.4

DIG IN!

Teacher Manual

Connecticut State Department of Education
Bureau of Curriculum and Instruction

Acknowledgement

The Connecticut State Department of Education is grateful to the many dedicated science educators who contributed to the development of the elementary, middle and high school curriculum-embedded performance tasks and teacher manuals. Beginning with the initial ideas for tasks, through the classroom field testing and editing, to the guidelines for classroom implementation, these inquiry teaching and learning activities are the result of the creativity, experiences and insights of Connecticut's finest science educators. We thank all of you, too numerous to list, who gave your time and energy so generously to this project.

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OVERVIEW OF THE ELEMENTARY AND MIDDLE SCHOOL CURRICULUM-EMBEDDED PERFORMANCE TASK MODEL

The Connecticut State Board of Education approved the Core Science Curriculum Framework in October of 2004. The framework promotes a balanced approach to PK-12 science education that develops student understanding of science content and investigative processes.

WHAT IS A CURRICULUM-EMBEDDED PERFORMANCE TASK?

Curriculum-embedded performance tasks are examples of teaching and learning activities that engage students in using inquiry process skills to deepen their understanding of concepts described in the science framework. Developed by teachers working with the Connecticut State Department of Education, the performance tasks are intended to influence a constructivist approach to teaching and learning science throughout the school year. They will also provide a context for CMT questions assessing students' ability to do scientific inquiry.

The three elementary performance tasks are conceptually related to Content Standards in Grades 3 to 5 and the three middle school performance tasks are related to Content Standards in Grades 6 to 8. The elementary performance tasks provide opportunities for students to use the Inquiry Expected Performances for Grades 3 to 5 (see Science Framework B.INQ 1-10 skills) to understand science concepts. The middle school performance tasks provide opportunities for students to use the Inquiry Expected Performances for Grades 6 to 8 (see Science Framework C.INQ 1-10 skills) to understand science concepts.

Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry process skills to deepen understanding of science concepts. Students who regularly practice and receive feedback on problem-solving and critical thinking skills will steadily gain proficiency.

HOW ARE THE PERFORMANCE TASKS STRUCTURED?

Each performance task includes two investigations; one that provides some structure and direction for students, and a second that allows students more opportunity to operate independently. The goal is to gradually increase students' independent questioning, planning and data analysis skills. The elementary performance tasks introduce students to understanding and conducting "fair tests". The middle school performance tasks focus on designing investigations that test cause/effect relationships by manipulating variables.

Mathematics provides a useful "language" for quantifying scientific observations, displaying data and analyzing findings. Each curriculum-embedded performance task offers opportunities for students to apply mathematics processes such as measuring, weighing, averaging or graphing, to answer scientific questions.

Not all science knowledge can be derived from the performance of a hands-on task. Therefore, each curriculum-embedded task gives students opportunities to expand their understanding of concepts through reading, writing, speaking and listening components. These elements foster student collaboration, classroom discourse, and the establishment of a science learning community.

A useful structure for inquiry-based learning units follows a **LEARNING CYCLE** model. One such model, the "5-E Model", engages students in experiences that allow them to observe, question and make tentative explanations before formal instruction and terminology is introduced. Generally, there are five stages in an inquiry learning unit:

- **Engagement:** stimulate students' interest, curiosity and preconceptions;
- **Exploration**: first-hand experiences with concepts without direct instruction;
- **Explanation:** students' explanations followed by introduction of formal terms and clarifications;
- **Elaboration:** applying knowledge to solve a problem. Students frequently develop and complete their own well-designed investigations;
- **Evaluation:** students and teachers reflect on change in conceptual understanding and identify ideas still "under development".

The performance tasks follow the "5-E" learning cycle described above. However, the teacher can decide the role the performance task will play within the larger context of the entire learning unit. Early in a learning unit, the performance task can be used for engagement and exploration; later in a learning unit, the performance task might be used as a formative assessment of specific skills.

HOW ARE PERFORMANCE TASKS USED WITH YOUR CLASS?

Curriculum-embedded performance tasks are designed to be used as part of a learning unit related to a Framework Content Standard. For example, while teaching a unit about human body systems (Content Standard 7.2,) the teacher decides the appropriate time to incorporate the "Feel The Beat" performance task to investigate factors affecting pulse rate. In this way, the natural flow of the planned curriculum is not disrupted by the sudden introduction of an activity sequence unrelated to what students are studying.

The performance tasks are NOT intended to be administered as summative tests. Students are not expected to be able to complete all components of the tasks independently. Teachers play an important role in providing guidance and feedback as students work toward a greater level of independence. Performance tasks provide many opportunities for "teachable moments" during which teachers can provide lessons on the skills necessary for students to proceed independently.

There is no single "correct" answer for any of the performance tasks. Students' conclusions, however, should be logical, or "valid" interpretations of data collected in a systematic, or "reliable" way. Variations in students' procedures, data and conclusions provide opportunities for fruitful class discussions about designing "fair tests" and controlling variables. In the scientific community, scientists present their methods, findings and conclusions to their peers for critical review. Similarly, in the science classroom, students' critical thinking skills are developed when they participate in a learning community in which students critique their own work and the work of their peers.

Performance tasks should be *differentiated* to accommodate students' learning needs and prior experiences. The main goal is to give all students opportunities to become curious, pose questions, collect and analyze data, and communicate conclusions. For different learners, these same actions will require different levels of "scaffolding" as they move toward greater levels of independence. For example, if students have had experiences creating their own data tables, the teacher may decide to delete part or all of the data table included in the performance task. Other possible adjustments include (but are not limited to):

- Text readability;
- Allowing students to control all or some of the variables;
- Whether the experimental procedure is provided or student-created;
- Graph labels and scales provided or student-created;
- Expectations for communication of results; or
- Opportunities for student-initiated follow-up investigations.

There are many science investigations that are currently used in schools that provide inquiry learning opportunities similar to those illustrated in the performance tasks. Students need a variety of classroom experiences to deepen their understanding of a science concept and to become proficient in using scientific processes, analysis and communication. **Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry processes and critical thinking skills.**

HOW ARE THE PERFORMANCE TASKS RELATED TO THE CMT?

The new Science CMT for Grades 5 and 8 will assess students' understanding of inquiry and the nature of science through questions framed within the CONTEXT of the curriculum-embedded performance tasks. Students are not expected to recall the SPECIFIC DETAILS OR THE "RIGHT" ANSWER to any performance task. The questions, similar to the examples shown below, will assess students' general understandings of scientific observations, investigable questions, designing "fair tests", making evidence-based conclusions and judging experimental quality.

Here is an example of the type of multiple-choice question that might appear on the Grade 5 Science CMT. The question is related to the "Soggy Paper" performance task:

> Some students did an experiment to find out which type of paper holds the most water. They followed these steps:
>
> 1. Fill a container with 25 milliliters of water.
> 2. Dip pieces of paper towel into the water until all the water is absorbed.
> 3. Count how many pieces of paper towel were used to absorb all the water.
> 4. Repeat with tissues and napkins.
>
> If another group of students wanted to repeat this experiment, which information would be most important for them to know?
>
> a. The size of the water container
> b. The size of the paper pieces *
> c. When the experiment was done
> d. How many students were in the group

Here is an example of the type of constructed-response question that might appear on the Grade 8 Science CMT. The question is related to the "Feel The Beat" performance task:

> Imagine that you want to do a pulse rate experiment to enter in the school science fair. You've decided to investigate whether listening to different kinds of music affects people's pulse rate.
>
> Write a step-by-step procedure you could use to collect reliable data related to your question. Include enough detail so that someone else could conduct the same experiment and get similar results.

NOTE THAT THE CMT QUESTIONS DO NOT ASSESS A CORRECT "OUTCOME" OF A PERFORMANCE TASK OR STUDENTS' RECOLLECTION OF THE DETAILS OF THE PERFORMANCE TASK. Students who have had numerous opportunities to make observations, design experiments, collect data and form evidence-based conclusions are likely to be able to answer the task-related CMT questions correctly, even if they have not done the state-developed performance tasks. However, familiarity with the context referred to in the test question may make it easier for students to answer the question correctly.

INTRODUCTION TO "DIG IN"

In this performance task, students will explore the properties of different soils that affect how water moves through them. After preliminary observations of the composition and texture of different soils, students will conduct experiments to explore factors that affect how much water the soils can hold and how quickly water moves through them.

SAFETY NOTES:

- Review expectations for appropriate behavior, handling of materials and cooperative group procedures prior to beginning this investigation.
- BE SURE TO HAVE ALL STUDENTS WASH THEIR HANDS WITH SOAP AND WARM WATER AFTER HANDLING SOILS. You may also have students wear hypoallergenic safety gloves.
- If soil samples will be collected from the school grounds, use appropriate digging tools (not bare hands) and remove any hazardous debris.
- Advise the custodial staff that you will be working with wet soils for about a week. Ask if you should use any special precautions or clean-up methods. You may want to line sink drains with mesh screen to keep even small amounts of soil out of the drain pipes.
- Water spills on tile floors can make the floors slippery. Provide each group with a damp sponge so that any water spills can be immediately mopped up.
- Plan ahead for the disposal of soil materials. If you collect the wet soil samples in 5-gallon plastic buckets, you can reuse them next year. If you don't have space to store the buckets of soil, you can collect manageable quantities of wet soils in heavy-duty trash bags and spread them outdoors or dispose of them. DO NOT wash soil samples down sinks; they will clog the drains.
- For more comprehensive information on science safety, consult the following guidelines from the American Chemical Society - **http://membership.acs.org/c/ccs/pubs/K-6_art_2.pdf** and the Council of State Science Supervisors - **http://www.csss-science.org/downloads/scisaf_cal.pdf**

FRAMEWORK CONTENT STANDARD(S): Dig In can relate conceptually to any of the following learning units:

6.1 - Materials can be classified as pure substances or mixtures, depending on their chemical and physical properties.

This is a learning unit about mixtures and solutions. Soil is a good example of a mixture of mineral particles, air, water, and organic material. Dig In can provide opportunities for students to explore how the components of a mixture (i.e., soil) can be separated using physical and chemical methods such as sieves, filters or evaporation. The minerals and nutrients needed by plants are dissolved in a solution of water within the soil. Before a nutrient can be used by plants it must be dissolved in the water that penetrates the soil.

Most minerals and nutrients are more soluble or available in acid soils than in neutral or slightly alkaline soils. Soil nutrient testing is one way that solutions can be studied.

6.2 - An ecosystem is composed of all the populations that are living in a certain space and the physical factors with which they interact.

This is a learning unit about the interactions between living and nonliving components of an ecosystem. Dig In can provide opportunities for students to learn about how soil conditions are affected by many variables, including climate, topography, geology, and human activity. Soils, in turn, play a major role in determining plant growth in an area; and the variety of plants in an ecosystem determine its community of animals.

6.4 - Water moving across and through earth materials carries with it the products of human activities.

This is a learning unit about how topography and soil types affect the way in which water moves across and through the land. Dig In can provide opportunities for students to study how human activities such as agriculture, land development or logging, can change soil properties by adding pollutants or causing compaction. Students can explore the impact of soil compaction on the way water flows across and through the soil.

UNDERLYING SCIENCE CONCEPTS (KEY IDEAS):

- Soil is the surface layer of the Earth;
- Soil is a mixture of living/once living and nonliving materials, such as broken rocks, water, air, minerals;
- Soil supports the growth of plants;
- Soil particles can be different sizes, depending on the parent rock material and the erosion forces;
- Soils can be classified as sand, silt, clay or loam, depending on the size of the particles and the amount of organic material;
- Soil particle sizes determine how well the soil holds air and water;
- A soil’s ability to hold air and water determine its ability to support the growth of trees and crops, and to provide stability for roads and houses.

KEY INQUIRY SKILLS

- Pose investigation questions based on observations;
- Use simple measurement tools to collect data;
- Identify dependent and independent variables and constants;
- Present data in an organized format;
- Use mathematics to analyze data;
- Interpret data to form conclusions;
- Apply experimental results to solve problems.

MATERIALS NEEDED: Listed below are all the materials needed to complete the two experiments in Dig In. Some materials are supplied in starter kits provided by the Connecticut State Department of Education. These materials are marked with an asterisk (*). The remaining materials are supplied by the school district:

For each lab group:	For each student:
4 plastic bottles (2-liter)	
About 1 liter each of 4 different soil types (in labeled zip-loc bags)	Scissors
• Sand	Hand lens
• topsoil or potting soil	Plastic spoon
• clay soil, powdered clay or cat litter (no additives)	Gloves *
• home soil sample (optional)	
• school campus soil sample (optional)	
Piece of fine mesh (panty hose), screen, or cheesecloth	
Duct tape	
500 mL beaker *	
100 mL graduated cylinder *	
Water	
Damp sponge	
Stopwatch or clock	

ADVANCE PREPARATION FOR THE TEACHER:

1. Carefully read through all teacher and student materials. Modify the Student Materials based on the needs of your students. Then print and photocopy Student Materials.
2. Obtain appropriate quantities of topsoil, sand, and clay soils so each lab group will have enough soil to conduct two experiments. The exact amount of soil needed depends on the volume of the testing containers you will be using. In general, fill the container with soil to within an inch of the top. Classroom quantities of different soil types can be ordered from most science education suppliers, hardware stores or landscaping suppliers. If you have difficulty finding a clay-type soil, you may substitute cat litter without any additives. Here is a link to one supplier: **http://sciencekit.com/category.asp_Q_c_E_756633**
3. If you choose to include school soil samples in the experiments, get an administrator's approval to dig a sample (or samples) of the schoolyard soil. A 5-gallon bucket should suffice.
4. About a week before beginning, ask students to bring clean, empty 2-liter plastic bottles to class. Again, you may alter the size of the bottles you choose to use, or substitute other soil testing equipment you may have. Each lab group will need 4 bottles if 4 different soil types are being compared. When you begin the experiments, lab groups can cut their bottles in half to make the soil testing devices. Cutting the bottles will be easier for students if you do some advance preparation: Use a box cutter to make a starting slice into each bottle's mid-section. Then store the bottles in large plastic trash bags until you're ready to begin the activity.

MATERIALS DISTRIBUTION:

Get students involved in distributing and returning materials. This saves time for the teacher and also teaches students collaborative skills and self-reliance. One way to distribute materials is through a "cafeteria style" distribution center. All materials are laid out on a table or counter, and each group sends a representative to pick up the required materials. Trays or plastic shoeboxes work well for transporting materials from the center to the lab groups.

ESTIMATED COMPLETION TIME AND PACING SUGGESTIONS:

You should reserve about a week for this activity – 5 periods or 3 blocks.

If you will teach in 40-45 minute periods:

Class	Activity	Homework
1	Pre-lab discussion, group assignments, Experiment #1 – steps 1-2	Experiment #1 – steps 3-5
2	Groups compare individual procedures, complete Experiment #1 – steps 6-7	Experiment #1 – step 8
3	Discuss Results & Conclusions, Experiment #1 – step 13, discuss other soil properties, introduce Experiment #2 – steps 1-2	Experiment #2 – steps 3-5
4	Groups compare individual procedures, complete Experiment #2 – step 6-7	Experiment #2 – steps 8-9
5	Discuss Results & Conclusions, Experiment #2 – step 10	"Communicate Your Conclusions" section

If you will teach in 80-90 minute blocks:

Class	Activity	Homework
1	Pre-lab discussion, group assignments, Experiment #1 – steps 1-2 *(this might be the second half of the block only)*.	Experiment #1 – steps 3-5
2	Groups compare individual procedures, complete Experiment #1 – steps 6-9, discuss other soil properties, introduce Experiment #2 – steps 1-2	Experiment #2 – steps 3-5
3	Groups compare individual procedures, complete Experiment #2 – step 6-10	"Communicate Your Conclusions" section

PEDAGOGY: Consult the teacher notes accompanying each step of the performance task for suggestions related to classroom implementation, differentiation, assessment and extension strategies. The ▲ symbol is used to indicate a differentiation opportunity. Each Teacher Note is followed by a reference to the Framework inquiry skill featured in that task component. For example, the notation "**C INQ.3**" indicates an inquiry skill related to designing or conducting a simple investigation.

Dig In!

A Guided Exploration of How Water Moves Through Soil

ENGAGE

When you think of soil, you may think of just plain dirt. Look again at the picture of the soil on the cover. Can you see some things that are mixed in with the soil? Are there other materials that are mixed in that are not so easily seen?

Teacher notes: To peak students' interest, you may distribute zip-lock bags that contain the soil samples from the school grounds or from students' homes. Compared with the soil types you may have purchased, these samples are more likely to contain mixtures of grass, roots, insects, pebbles, etc. Let the students observe the soils inside the bags, and generate a class list of the materials they can see, as well as those which may be inferred from evidence (e.g., moisture, air, or minerals). Ask students "Is soil a pure substance or a mixture? How do you know?"

EXPLORE

Imagine that your class will be planting a vegetable garden as part of a study about ecosystems. You need to choose the best location for the garden, and one of the important factors is the type of soil.

In this activity, you will observe and compare different types of soil. Then you will investigate factors that may affect how much water the soils can hold and how quickly water can pass through them. Finally, you will apply the results of your investigations to make decisions about the location of a new garden.

1. **Observe** the different soil samples with and without the hand lens. Notice different properties such as color, grain size, lumpiness, etc. Do you notice anything that is alive or was once alive?

Teacher notes: Cover the work space with newspaper. Plain white paper is a good background for observing different soil types. Encourage students to organize their observations by labeling their samples. Show students how to moisten their fingers and rub the soils between fingertips to detect differences in particle size. Suggest that students explore how well the soil "holds together" by making little "snakes" or balls. Discuss how scientific observations differ from facts, names, opinions or theories. **C INQ.1**

2. **Record** your observations in your science notebook. Make an organized list of things you notice and things you wonder.

Teacher notes: ▲ *If your students are experienced at using observation tables, they should be able to design their own organized table to record the properties of the different soil types. As you circulate during this activity, you may notice that some of your students need more structure. If this is the case, you can suggest a blank table, like this:*

SOIL TYPE	NOTICE	WONDER

This is a useful strategy for helping students turn their exploratory observations into productive questions that can be investigated later on. **C INQ.1**

3. Identify a property that may be related to the soil's ability to hold water. This property is called **"absorbency"**. Write a research question that can be answered by doing an experiment.

Teacher notes: Encourage them to think about what soil property might be related to water retention. Students may theorize about properties such as the size of the soil particles, the soil color, how compacted it is, or how much organic material is in it. Their experiment will allow them to test their idea. Help students to distinguish between a question that cannot be answered through an experiment (e.g., "What gives soils their color?") and a question that can be answered through an experiment (e.g., "Does soil color affect its absorbency?"). Some questions are best answered by researching electronic or print information, while others can be answered by collecting first-hand data. **C INQ.1**

Experiment #1 – Relationship Between Soil Properties and Water Absorption

1. Gather the following materials to use in planning and conducting your experiment:

For each lab group:
2-liter plastic bottles
1 liter each of 4 different soil types (in labeled zip-loc bags)
- Sand
- topsoil or potting soil
- clay soil, powdered clay or cat litter (no additives)
- home soil sample (optional)
- school campus soil sample (optional)

Piece of fine mesh, panty hose, screen, or cheesecloth
Duct tape
500 mL beaker
100 mL graduated cylinder
Water
Stopwatch or clock

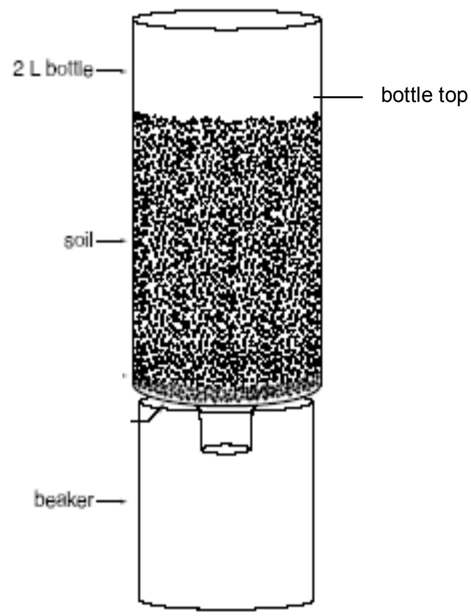
For each student:
Scissors
Hand lens
Plastic spoon
Gloves

2. To conduct your experiment, you can make a soil testing device like the one in the diagram:

   a. Cut the plastic bottle across the middle. Remove the labels and the caps. The bottle top will hold the soil, and the beaker (or the bottle bottom) will catch the water.

   b. Position the mesh near the bottle neck so it will keep the soil in the bottle top.

   c. Rest the bottle top, neck down, on the bottle bottom so that water poured through the soil in the bottle top will flow into the bottle bottom.



Teacher notes: ▲ *The diagram shows one of several ways this device can work. Depending on the materials you are using, allow students to use their creative problem-solving skills to design their apparatus so they can collect the data they think is important for their research. One way to keep the soil in the top container is by wrapping the mesh around the bottle neck using duct tape.* **C INQ.5**

3. **Design** a procedure that will help you answer your research question. List the steps you will follow in your science notebook. Include enough detail so that anyone could repeat your experiment.

Teacher notes: Allow students ample time to talk with their lab partners about their experimental design. They need to be clear on their research question (e.g., "Does Soil Grain Size Affect Its Ability to Hold Water?") and how they can control all the variables to collect reliable data related to the question. ▲ ***Different lab groups may explore different independent variables, or you may structure the activity so that all lab groups explore the effect of organic materials or soil grain size.*** **C INQ.3**

4. In this experiment, the **dependent** variable is the soil absorbency. In your science notebook, record the **independent** variable you will investigate and the variables that must be kept constant in your experiment.

Teacher notes: ▲ *If your students are not experienced designing controlled experiments, you may lead a class discussion about the dependent variable (the one thing that will change) and the independent variable (the outcome to be measured).* **C INQ.4**

5. Design a **data table** to record your findings in your science notebook.

Teacher notes: ▲ *Remind students that the data table is useful for recording all quantities used in the procedure. For those students who are not yet proficient at designing their own data tables, you may want to provide them with part or all of a table like this:* **C INQ.5**

SOIL TYPE	SOIL AMOUNT	WATER POURED IN (in mL)	WATER THAT CAME OUT (in mL)	AMOUNT OF WATER LEFT IN SOIL (in mL)

6. Do your **experiment** and record your findings. Do the data seem reasonable? If not, do you need to repeat any trials to correct errors?

Teacher notes: This is a good opportunity to hold a class discussion about the need to do multiple trials in an experiment. Ask students what might be different if they did multiple trials of the absorbency test. Students are likely to comment that the first absorbency test was through dry soils; if they repeated the test, the soils will be wet. Ask them if they think there will be any difference in the results. They may want to collect additional data to compare dry soil absorption to wet soil absorption. Remind them to modify their data tables to incorporate the multiple trials. **C INQ.5**

7. **Calculate** the amount of water remaining in each soil.

8. *Teacher notes: Now is the time to use mathematics to process the raw scientific data. Some students may need prompting to recognize the "inverse relationship" between the amount of water collected in the beaker compared to the starting amount that was poured into the soil. When students use subtraction to compare the ending water amount to the beginning water amount, they should be able to deduce* ***that the amount of water that is not in the collection beaker must be left in the soil.*** *If students conducted multiple trials, guide them to recognize the need to find the average amount of water retained by each soil in order to form a conclusion.* **C INQ.6**

9. Interpret the data. Use your calculations to help you reach a conclusion about what properties affect soil absorbency (how much water the soil holds).

Teacher notes: **C INQ.8**

10. Share your procedures and conclusions with others in your class. How are they alike? How are they different? What changes could be made to the procedures to make the results more similar?

Teacher notes: Lead a post-lab discussion in which data is displayed from lab groups who investigated the same independent variable. This is a great opportunity to discuss reasons for possible differences in results among lab groups. When students share their methods, others should comment about whether variables were properly controlled. Good time to talk about "experimental errors" that might affect student confidence in their results. **C INQ.8**

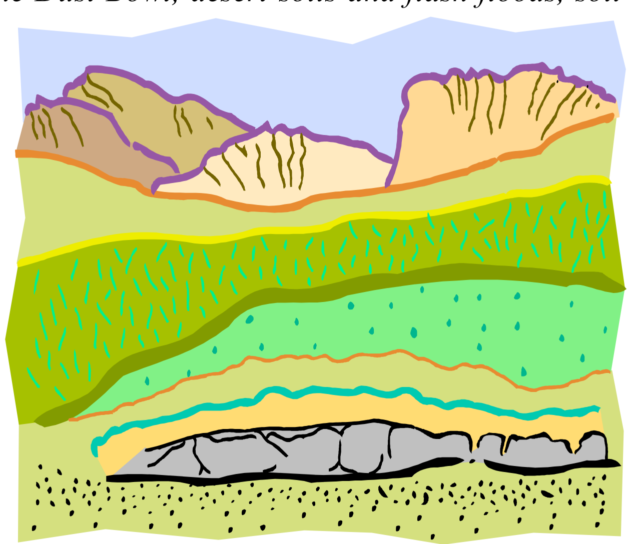
EXPLAIN

Investigate Through Research

The food we eat and water we drink, in many ways, depend on the quality of the soil. Do some research in books, magazines or the Internet to find out more about what soil is, where it comes from, different soil types and how wet and dry soils affect an ecosystem.

Write a reflection in your science notebook that explains your understanding of how the soil type affects what grows in a particular area.

Teacher notes: Some answers to questions come from experimental research, while others come from reading about what is already known. Often, the information gained from the reading leads to other questions that can be investigated experimentally. You can modify this step to reflect the focus of your learning unit. Other research topics include: Deforestation and Soils, Weather and Soils: The Dust Bowl, desert soils and flash floods, soil types, mudslides and sink holes, etc.



ELABORATE

Investigating Further

Experiment #2 – Relationship Between Soil Properties and Water Percolation Rate

In this investigation, you will explore properties that affect how quickly water moves through different soil types. This is called the soil's "**percolation rate**".

1. **Observe** the different soils again. What are your ideas about soil properties that might be related to soil percolation? Discuss your ideas with your partners.
2. **Predict** which soil type might have the fastest percolation rate based on the properties you observed.
3. **Write** a procedure that will help to answer your question. To conduct your experiment, you can use a soil testing device like the one used in Experiment #1. List the steps you will follow in your science notebook. Include enough detail so that anyone could repeat your experiment.
4. Identify the **dependent and independent variables** in your experiment. Identify the variables that will be kept **constant** in your experiment.
5. Create a **data table** to record your findings in your science notebook.
6. Do your **experiment** and record your findings.
7. Think about the data you have collected. Do the data seem reasonable? If not, do you need to repeat any trials to correct any problems?
8. **Analyze** the data. Calculate the average time it took for the water to move through each of the soils.
9. **Interpret** the data. What **conclusions** can be made based on your data?
10. **Share** your procedures and conclusions with others in your class. How are they alike? How are they different? What changes could be made to the procedures to make the results more similar?

Possible Variations/Extensions (optional):

Some plants prefer moist soil, while others prefer dry soil. You may want to find out if a soil's moisture content can be changed by experimenting with different soil combinations.

Applying Your Findings To Solve A Problem

Imagine that you are going to plant a vegetable garden at your school or at home. You need to know what type of soil you have so you can select the right plants and know how much or how often you will need to water them. Use what you've learned through your experiments and your research to describe the type of soil in the school or home sample you have tested.

Communicate Your Conclusions:

Make a recommendation to the school principal about where the garden should be planted and how much watering it will need. Write an expository report that includes the following:

- An introduction that summarizes your research questions and findings;
- A description of the different soils you observed and how they were tested;
- A description of the school soil type and how it is similar to or different than the other samples you tested;
- A recommendation about whether the school garden should be planted in the area from which you took your test sample; and
- A conclusion that suggests areas for further research needed before planting the school garden.

Teacher notes: If you have elected not to pursue the authentic garden-planning scenario, you may modify this science writing assignment to require students to describe their observations, questions, methods and conclusions in a variety of ways: **C INQ.10**

- *A formal lab report;*
- *A narrative article for a scientific journal; or*
- *An article for the school newspaper.*

TEACHING RESOURCES

SOIL LEARNING UNITS:

http://archive.globe.gov/tctg/tgchapter.jsp?sectionId=86&rg=n&lang=en - GLOBE (Global Learning and Observations to Benefit the Environment) is a worldwide hands-on, primary and secondary school-based education and science program.

http://www.fieldmuseum.org/undergroundadventure/teachers/index.shtml

http://www.urbanext.uiuc.edu/gpe/index.html - Soil and plant investigations and information for upper elementary grades.

http://www.scienceteacher.org/k12resources/lessons/lesson15.htm - an inquiry into the effect of soil microorganisms on the germination of grass seeds. University of Montana.

CLASSROOM ACTIVITIES:

Washington, D.C.: U.S. Department of Agriculture, 2001.
Available online: soils.usda.gov/sqi/files/activities.pdf
http://soils.usda.gov/sqi/files/activities.pdf
This series of three soil-related classroom activities focuses on decomposition, earthworms, and other creatures that live in the soil.

http://www.acornnaturalists.com/store/category.asp?SID=2&Category_ID=543 – Topsoil Tour and other soil and water investigational units.

Eco-Inquiry: A Guide to Ecological Learning Experiences for the Elementary/Middle Grades
Kathleen Hogan
Dubuque, Ia.: Kendall/Hunt Publishing Company, 1994.
ISBN: 0840395841
The cooperative approach in this guide organizes students from ages 8-13 into research teams to carry out investigations on food chains, decomposition, and cycles, and then to present their findings to peers. It provides authentic assessment tools and emphasizes group learning.

http://www.epa.gov/region01/students/pdfs/ww_well.pdf - This series of seven activities allows students to demonstrate knowledge about what ground water is, explain how it moves through the **soil** and how it interacts with surface water, and learn how it is extracted for use as drinking water.

Grow Your Own Garden
Learn everything you need to start your own garden.
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