# Science Unit: *The Earth Around Us: Air, Water & Soil*

# Lesson 13: *Soil composition and Erosion: Free experimentation*

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| School Year: | 2012/2013 |
| Developed for: | Sir Wilfrid Laurier Elementary School, Vancouver School District |
| Developed by: | Ingrid Sulston (scientist); Patricia Ellis and Barbara Duncan (teachers) |
| Grade level: | Presented to grades 1-3; appropriate for grades K – 4 with age appropriate modifications |
| Duration of lesson: | 1 hour and 30 minutes |
| Notes: | Activity 1 in this lesson uses the same materials as Lesson 12, Soil Analysis, in The Earth Around Us; Air, Water & Soil unit, Scientist in Residence Program. http://scientistinresidence.ca/science-lesson-plans/the-earth-around-us-air-water-soil/ |

**Objectives**

1. Experience free, unguided investigations of a collection of materials, to independently discover patterns and phenomena.
2. Practice group reporting of observations, and uncritical discussions of similar and differing results.
3. Practice group problem solving and critical thinking to design further experiments.
4. Discover and categorize the varying components of different soil types.
5. Explore the interactions of soil and water and the results of erosion.

**Background Information**

Free experimentation is an often overlooked method of science teaching. Championed by Selma Wasserman and George Ivany in their “Play, Debrief, Replay” format (ref. 1 and summarized below), it promotes exploration, inquiry, self confidence, curiosity and excitement of science. Students often naturally make predictions, set up controls and develop hypotheses, as they realise their need in their investigations, even if they do not know their terminology. With some encouragement to record results and to focus in on one problem, students can rapidly become quite sophisticated investigators.

Unfortunately, free experimentation is not often done in classrooms, perhaps because it can be messy, the results are unknown or the students get quite loud with excitement. These of course can all be overcome, and I have found myself relaxing as I try this method more often.

Soil is a material that is well suited to open-ended investigations and can provide complex and interesting results.

**Summary of Play-Debrief-Replay model of science teaching**

Adapted from refs. 1 and 2.

Set-up

Set up enough stations so that students will not be crowded while working. Tell the students how much time you will give them for a particular centre (often 15-20 minutes, longer if the students are engaged). You can direct the students to investigating a particular aspect of the materials. In this lesson students were directed to the topics of soil composition and soil erosion. Alternatively, leave their investigations wide open to any (reasonable and safe) investigations.

Stage 1: Play

This is the time when the students freely experiment (or “play”) with the materials. Students can work together if they are all engaged in problem solving. The teacher circulates and is responsive to questions but does not make evaluative comments or direct the the students’ investigations in any way. If students are “stuck” and want help through a problem, the teacher can respond with open ended questions based on good scientific method: maybe suggestions to try other materials, repeat with different amounts, or to look at it from another direction.

I generally encourage note taking (including drawings) of what students put together and what they find. It is easy to forget what is done without them, and tempting to (often incorrectly) make up what happened. It is a good habit to take notes while experimenting and students do indeed refer to their notes often while reporting on what they found.

Stage 2: Debrief

Call the students away from the materials, bringing their notes with them. This is a time to report to others on what has been discovered, and to discuss (without judgement) similarities and differences in results.

Debriefing may spontaneously start, as students gather and then start to talk with their peers about what they found. Teacher management is likely needed after a while to make sure every student has contributed, or to point out similarities between students’ investigations that have gone unnoticed.

Towards the end of debriefing, I like to focus on one aspect of students’ investigations, and ask them to think about how they can delve deeper and solve one problem or answer one question they have. By the end of debriefing most students have a specific question to answer and a specific way to test it. Students might be grouped with others that are asking similar questions to work on something together. Additional materials might be needed for some investigations, or questions to pursue can be limited to those that use the materials already available.

Stage 3: Replay

Students return to the materials, focusing on their question/problem identified during Debrief. This is a time to stress use of controls, repeating experiments, and rigorous experimentation to obtain solid results (positive or negative). Students that did not come up with a problem to focus on are not put down in any way, but encouraged to continue free exploration of the materials. Students again take notes on what they set up and the results they get.

An optional additional Debrief can follow, or students could write a report on their focused investigation.

**Vocabulary**

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| Soil: | The loose covering on the earth’s surface, lying over solid rock. It is made up of rock particles mixed with organic matter. Soils vary in the ratio and types of organic and inorganic matter they contain. Soil is made by weathering and erosion. |
| Organic matter: | Material from living things, including living animals and dead plant/animal matter. Forest soil is mostly organic matter. |
| Inorganic matter: | Material from non-living things i.e. rocks, pebbles, sand. Beach soil is mostly inorganic matter. |
| Weathering: | The breaking apart of rocks into smaller particles. Weathering is facilitated by wind, water, ice, chemicals, heat and pressure. |
| Erosion: | Movement of soil or rock to new places on the surface of the earth. Erosion is facilitated by wind, water, ice and gravity. Human activities often increase the rate of erosion. |

**Materials**

- Soils collected from different locations e.g. forest/beach, and dried in a low oven.
- Wide, shallow trays to contain the soils, one tray of soil for each group of students.
- Sieves. Metal kitchen sieves from a dollar store work well.
- Additional wide, shallow trays to catch soil going through the sieves
- Fine soil or sand, one tray for each group of students.
- Water to partially cover the fine soil/sand in its tray.
- Small tubes or cups to pour water over soil/sand.
- Tarps or ground sheets, if the activities are done indoors. Ideally this lesson is run outside.
- Many towels for drying hands/clean up.
- Paper and pencil for students to report their results, marked into boxes for younger students to help them organize their notes.

## In the Classroom/at the outdoor experimentation area

**Introductory Discussion**

Introduce the topic of soil to provide some context for their soil investigations. We had already set up a worm compost bin (ref. 4), so we looked in the worm bin again and reviewed that the worms had eaten the vegetable scraps (dead plant matter), and made soil from them. The soil the worms made is rich in "organic matter" i.e. material derived from living things. Many soils also contain some "inorganic matter" i.e. matter that is non-living things like rocks and sand. Some soils are mostly made up of inorganic matter. Tell the students that the first activity is for investigating different soil types.

Tell the students that the second activity will look at how soil moves. Soils do not stay in one place - they can move around when they are picked up by wind, or carried along by water or ice. When soil is moved, different parts of the soil are moved in different ways. Students will investigate soil movement with water.

Tell the students that in both activities, there are no rules about how the materials are investigated, but the materials do need to remain at their own station. Students will be trying things that have not been tried before, so they should use the paper to take notes on what they do and find out. The class will experiment for about 15 minutes before switching stations. Then after everyone has done both activities, students bring their notes to a class dicussion on the discoveries made.

Brief description of science activities:

- Free experimentation to investigate the components of different soil types.
- Free experimentation to investigate how water erodes soil.

Brief description of the processes of science that the students will focus on: close observation, recording observations, exploration, curiosity, inferring, verbally summarizing and reporting results, experiment design.

**Science Activities**

(1) Activity Title: Free experimentation: soil composition

Purpose of Activity: For students to freely investigate the look, feel and components of different soil types. This is an adapted version of the sieving soil activity in ref. 3, using the Play-Debrief-Replay format outlined above.

Methods and Instructions:
Set-up prior to experiment: lay the trays of soil, the empty trays and sieves out on the grass (or on a tarp if indoors).
Students work individually, with several students at one tray.

1. Tell students this station is for investigating different soils and what they are made up of, using the sieves to help separate components. Students should be asked not to mix the different soil types, either in the trays or sieves.
2. Leave students to play, with the guidance outlined above (under "Summary of Play-Debrief-Replay model of science teaching").
3. Remind students to take notes on what they discover in the different soils.

   Depending on the soils collected, students will find differering amounts of organic and inorganic matter in different soil types. Forest soils are likely to be mostly organic mater, and beach soils mostly inorganic matter. Many soils will have a more even balance of organic and inorganic matter.
4. Debrief, maybe after doing both this activity and Activity 2 below. See point 4 onwards in Activity 2 below.

(2) Activity Title: Free experimentation: soil erosion

Purpose of Activity: For students to freely investigate how soil moves around when water flows over it.

Methods and Instructions:
Set-up prior to experiment: lay the trays of soil and water out on the grass (or on a tarp with many towels available if indoors).
Students work individually, with several students at one tray.

1. Tell students this station is for investigating how water moves soil/sand around, how the different components of the soil are moved differently, and what shapes are formed as the water flows over the soil. (Children love to interact with sand and water - there are many possibilities for play. Some focusing of the types of play is required if this activity is to be on soil erosion.)
2. Ask students to experiment for a while before they take a break to dry their hands and take notes. (Notes become quite wet if they are at the work area.)
3. Leave students to play, with the guidance outlined above (under "Summary of Play-Debrief-Replay model of science teaching"). If necessary, question students on what they are finding out about how water moves the soil/sand around or how the different soil particles move, to redirect them to soil erosion concepts. For example, students are likely to start piling the sand up to make dams and other structures - students can be encouraged to pour water over these to test how they are eroded. Some of our students explored how the compacted wet soil can form a solid chunk, which can also be tested for resistance to water flow and erosion. If students are discovering interesting properties of soil and water interactions that are not necessarily related to erosion, the lesson can widen into these other topics.
4. Debrief, maybe after doing both activity 1 and 2. Students are likely to be very excited about their results so allow time for them to talk together before starting a more formal class discussion. Encourage students to refer to their notes to remember exactly what they did and what happened.

   Once results have been heard, ask students to think of one aspect of the activities they were particularly interested in, or one question they have about soil that they could investigate further with the materials. Students take turns to tell the class their ideas for further experiments, and propose ideas on how they could experiment further to answer their question. Turn to the class to brainstorm a topic if necessary, remembering that no judgement of ideas is allowed. Students that are interested in the same topics can work together on how to design their next experiments. Some students will not have any questions - that is OK - they can return to free experimentation after the discussion.
5. Return to the materials for Replay. Encourage students to do controls and repeat experiments to thoroughly investigate the phenomenon they are interested in. Encourage note taking. Run the replay until time runs out, or students are becoming unfocused.

**References**

1. Wassermann, Selma and Ivany, J.W. George. 1996. The New Teaching Elementary Science: Who's Afraid of Spiders? Teachers College Press.
2. <http://www.usask.ca/education/coursework/mcvittiej/methods/play.html> Summary of the Play-Debrief-Replay teaching method, part of a University of Saskatchewan Education class, taught by Janet McVittle. Accessed May 26, 2013.
3. <http://scientistinresidence.ca/science-lesson-plans/the-earth-around-us-air-water-soil/> Lesson 12, Soil Analysis, in The Earth Around Us: Air, Water & Soil unit, Scientist in Residence Program.
4. <http://scientistinresidence.ca/science-lesson-plans/discovering-life-in-local-habitats/> Lesson 9, Worms, in the Discovering Life in Local Habitats unit, Scientist in Residence Program.

**Extension of Lesson Plan**

For further investigations on soil erosion, a suggested lesson is Lesson 3, Erosion, in The Earth Around Us: Air, Water & Soil unit, Scientist in Residence Program, at http://scientistinresidence.ca/science-lesson-plans/the-earth-around-us-air-water-soil/ This is a lesson of structured activities, but would follow well from this free experimentation lesson.