THE WATER (HYDROLOGIC) CYCLE: GROUND WATER MOVEMENT

OBJECTIVES:

- Students will list and describe the forces responsible for capillary action.
- Students will measure how long it takes for water from the reservoir of an EarthBox to completely moisten dry potting mix.
- Students will measure the amount of water absorbed by the dry potting mix.

FOCUS:


NATIONAL STANDARDS ADDRESSED:

Science (National Science Education Standards)
I, A.1, D.2
Mathematics (Principles and Standards for School Mathematics)
Numbers and Operations, Measurement, Data Analysis and Probability
Reading and Writing (Standards for the English Language Arts)
5

MATERIALS:

- One EarthBox kit
- An empty 1-gallon milk container and measuring cup or other graduated measuring device for watering the EarthBox.

IMPORTANT NOTE – THIS LESSON REQUIRES DAILY OBSERVATIONS AND SHOULD BE STARTED ON A MONDAY TO AVOID HAVING IT RUN INTO THE WEEKEND

PROCEDURE:

PART I, 45 MINUTES

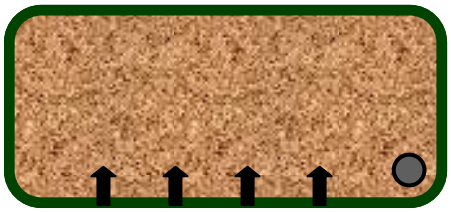
STEP 1: Have students take turns reading the EarthBox instructional booklet out loud. As a class, set up the EarthBox according to the instructions with the following exceptions:

- Do not add any water to the potting mix as you fill the EarthBox. Fill the EarthBox with dry potting mix only. If you are using an EarthBox that is already set up, make sure that the potting mix is thoroughly dry before using it.
- Do not add any water to the reservoir.
- No plants are necessary for this activity, so do not plant anything in the EarthBoxes, do not add fertilizer, and do not cut holes in the plastic cover.

STEP 2: Once the EarthBox has been set up according to the modified instructions above, have a student fill the reservoir through the fill tube until water runs out the drain hole. Have the students note the day and time in the appropriate space (start time) on their activity sheets. ***Activity A*** Have the students write predictions on their activity sheets about how long it will take for water from the reservoir to completely moisten the dry potting mix.

STEP 3: ***Activity B*** Once a day, starting one day after setting up the EarthBox, pull back the plastic cover and have three or four students stick their fingers into the potting mix on the side of

the EarthBox that has the watering tube (see the diagram to the right – the arrows indicate where students should sample the potting mix). The students should be checking to see if the potting mix is wet or dry to the touch. Have the class record the results for the day on their activity sheets.



STEP 4: After sampling the potting mix each day, the water reservoir needs to be filled. Ask the class to determine the appropriate unit of measure (cups, ounces, milliliters) to use when filling the EarthBox during the experiment. Then, have a student add water to the reservoir in small, measured amounts using the measuring cup or other graduated measuring device. Add the water slowly and stop adding water as soon as water is seen dripping out of the drain hole. After the student has watered the EarthBox, have the entire class record on their activity sheets the volume of water added to the EarthBox.

PART II, 45 MINUTES

STEP 5: When students clearly detect that the potting mix in the EarthBox is moist to the touch, the experiment is complete. Have them note the day and time on their activity sheets. Have a student add a measured amount of water to fill the reservoir one final time, and have the class write this amount on their worksheets. ***Activity C*** Allow the students time to complete the calculations and questions worksheets. Then lead the class in a discussion of the underlying principles of the activity.

ANALYSIS & QUESTIONS:

- Why is this movement of water through the potting mix so important to any plant grown in an EarthBox?
- What other examples, if any, can you think of where you have seen water slowly move from a wet area to a dry area?
- How did your predictions compare to the actual results of the experiment?

EXPLANATION: Water, like many substances, has a natural tendency to move from areas where it is abundant to areas where it is scarce (high concentration to low concentration). In soil and other porous materials, water moves by the principle of **capillary action**. Capillary action occurs due to two forces: **cohesion** (the force that holds individual water molecules together) and **adhesion** (the force that makes water molecules stick to other surfaces). Water begins adhering to small particles of potting mix, and as it does so it slowly works into the small spaces between potting mix particles. Water molecules stick together, so as water adheres to additional particles of potting mix, cohesion allows for the continuous drawing of water from the water reservoir. Capillary action is also the force behind the movement of water from the roots to the leaves of a plant.

In this activity, water moved through the potting mix by capillary action. In a planted EarthBox, the roots of the plant take in water from the potting mix immediately adjacent to them. This locally dries out the potting mix, however capillary action replenished the drier potting mix with water drawn up from the reservoir. Capillary action will not work as well in soil types that are less porous, such as clay. The potting mix used in EarthBoxes is rich in organic matter and maintains a light, fluffy, porous texture, even when wet. This is crucial for capillary action to continue to bring water from the reservoir directly to the roots of the plants growing in them.

EXTENSION: Groundwater and water from precipitation can pose a large problem for landfills. If a material such as the potting mix used in EarthBoxes surrounds a landfill (both below and above the garbage and waste), what do you think would happen? Would we contaminate our groundwater supply with waste residue? Based on what you have learned from this activity, what kinds of soils do you think landfill designers might want to use to surround the waste?

If time permits, have the class run the experiment again, this time using a different type of soil. They may either use local soil from outside the school or topsoil or other mixes available from a local garden supply center. Whatever type of soil or mix the class uses, make sure it is thoroughly dry before starting the experiment and make sure that there is enough soil to fill the EarthBox (2 ft^3).

RESOURCES: The following is the USGS Water Science for Schools website:

http://ga.water.usgs.gov/edu/

The following is the Groundwater Foundation's Kids Corner website. It contains numerous games and activities as well as additional information about groundwater.

http://www.groundwater.org/kc/kc.html

NAME _____

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Start Date and Time for the Experiment _____

Activity A – Predictions

How long do you think it will take for water from the reservoir of the EarthBox to completely moisten the potting mix? _____

_____

Why? _____

_____

_____

_____

Activity B – Observations

Record the following for each day in the table below:

- The date
- Whether the potting mix was dry or wet when you (or other students) stuck your finger in it
- The amount of water, including the appropriate units (e.g. milliliters, cups, ounces) added to the EarthBox that day (NOTE – Day 1 is the start day, so no water will be added that day)

If there are extra spaces in the table, leave them blank.

Day	Date	Dry or Wet?	Water Added
1			
2			
3			
4			
5			

Activity C – Analysis and Questions

How many days did it take for water to completely moisten the EarthBox potting mix?

_____

What is the total amount of water added to the EarthBox water reservoir?

_____

You wish to figure out how much water the potting mix is holding. The EarthBox contains two cubic feet of potting mix. Use this volume and the total amount of water added to the reservoir during the experiment to figure out the volume of water in each cubic foot of potting mix. Can you also figure out how much water is in each cubic inch of potting mix? (Hint – one cubic foot is 1 foot x 1 foot x 1 foot, or 12 inches x 12 inches x 12 inches). Show your work below.

Questions

1. Describe in your own words how the water moved from the reservoir up into the potting mix. _____

   _____

   _____

   _____

   _____

2. How close was your prediction to the actual results of the experiment? _____

   _____

   _____

   _____

3. Do you think the potting mix used in EarthBoxes allows enough water to move to meet the needs of growing plants? _____ Why or why not? _____

   _____

   _____

   _____

4. Can you think of any example when you might want to have soil that prevents water from moving through it or else makes it move very slowly? _____

   _____

   _____

   _____

   _____