New Plants

Concepts
Water is a limited resource that is constantly being recycled. Plants depend on the water cycle to complete their life cycle. Different amounts of water are available in different environments.

Standards Addressed
HCPS III
SC.2.8.2
MA.2.4.1
SS.2.5.1
SS.2.7.3

Duration
30 min set-up +
five minutes, every other day.

Vocabulary
condensation
evaporation
precipitation
greenhouse
moisture
recycle
water cycle

Lesson 5: "Lettuce" Learn About the Water Cycle

Summary
Students plant lettuce seeds in ziplock bags, taped to the window. The water in their "greenhouses" evaporates, condenses on the bags, and precipitates back down to the lettuce, so that students actually see parts of the water cycle. While the water cycle is covered in more detail in third grade, this activity provides awareness. The direction and depth of this activity depends on discussions, and can lead toward water conservation, hydroponic gardening, local agriculture, or plant development. In follow-up activities, students have the opportunity to measure how much water is transpired by plants outdoors.

Objectives
- Students will be able to explain that water is a limited resource that can be recycled.
- Students will draw connections between the water cycle and a life cycle.
- Students will be able to describe some ways that agriculture has been improved by technology in water recycling (hydroponics, greenhouses).
- Students will measure the amount water transpired (evaporated) from a plant.

Materials
Per child
One snack-size zip-lock bag
One sharpie for writing name
Handful of moist potting soil
One pinch of lettuce seeds (anuenue or manoa for hot classrooms)
Lettuce Observations worksheet
Data Table Worksheet optional

For the class:
Masking tape
Window space
Optional: balance scale and data sheet (example at end of lesson)

Making Connections:

Water is the most important resource for sustaining life on earth. It is also unique, in that it can be recycled in many different ways. In fact, the earth does it constantly, in a process known as the water cycle. Farmers and landscapers know the importance of recycled water, whether it is naturally recycled by our forested watersheds, or recycled by people, like water reclaimed from treatment plants. Children living in the windward regions of our islands see rain quite often, where as children on the drier, leeward sides don't experience it as often. In the drier regions of our islands we learn to conserve, or save, water because it is a precious resource. The beautiful lettuce grown in Waimea, on the Big Island, and Waimanalo, on Oahu, uses a lot of water. Lettuce must be watered every day, either through irrigation or by rain. Why? Where does all that water go? Why do people conserve water?

Teacher Prep for Activity

1. Gather the materials.

2. Copy the Lettuce Observation Worksheet for each student. Staple into Science Journal. The "Data Table: Greenhouse Weight" worksheet is optional. Any instructions regarding this worksheet will be clearly labeled "*Optional*."

2. Put potting soil in a bin students can easily access. Wet potting soil and mix thoroughly. Soil should be moist, but not overly saturated. Put lettuce seeds in several cups for pinching.

3. Figure out how much space you need in the window for all the student's ziplock bags. Use masking tape to outline a simple house shape on the window. This is your greenhouse!

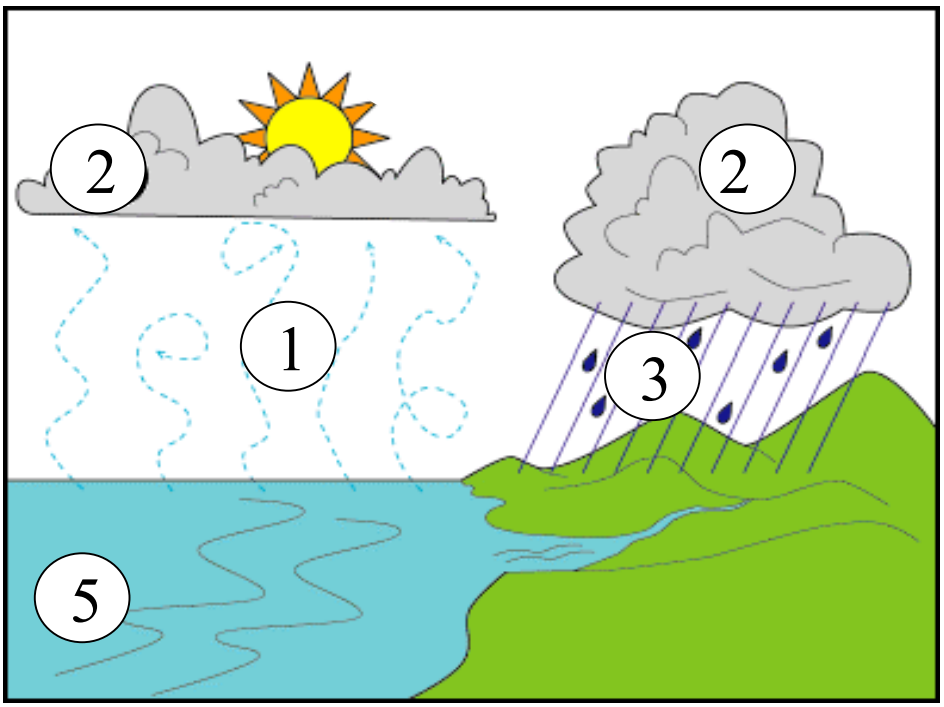
Background

Although low in nutrients and energy, lettuce (*Lactuca sativa*) is the most popular amongst the salad vegetable crops. You may not have ever thought about a lettuce flower, but lettuces are members of the Sunflower or Compositae Family, and have small yellow dandelion-like flowers, followed by fluffy, float-away seeds. Leafy types have been cultivated for over 2,500 years, by the ancient Greeks, and later, the Moors. 18 % of all lettuce eaten in Hawaii is grown in Hawaii! While it is mostly grown in the cooler, high elevations regions, like Waimea, there are varieties that do well even in hot climates—as long as they get plenty of water. A pound of lettuce contains 95% water, 56 calories, 3.9 g protein, 0.3 g fat, 86 mg calcium, 2.2 mg iron, 1,420 mg vitamin A, and 54 mg Vitamin C. So what exactly does a vegetable that is 95% water have to do with the water cycle?

Just like humans, all living things require water to survive. A lettuce plant can lose almost all its water to evaporation (technically, it's called transpiration when it comes from the leaves of a plant) in just one hot sunny day, if no more water is being supplied from the soil. So the water cycle can be observed very well by containing this watery plant in a plastic baggie. A limited amount of water is sealed in with the seeds of the plant, and no further water is added—but the plant survives. How? The water that the plant loses to evaporation in the heat of the day condenses on the sides of the baggie at night, and drips back into the soil to be re-used. Feel free

to review water cycle sites on the internet, such as http://www.kidzone.ws/water/ which has great simple background info and several worksheets to print out for free. Just remember, it is a cycle, with no beginning or endpoint (although the students may want to debate that!).

The basic steps of the water cycle are (1) **evaporation and transpiration** (transpiration just means evaporation directly from a plant), (2) **condensation** (cloud formation), (3) **precipitation** (rain, snow, mist), and (4) **collection** (into the ocean, lakes, or ponds).



http://cempaka.edu.my:8866/blog/sargunanathan/wp-content/uploads/water_cycle_quiz01.gif

In Hawaii, warm, moist air moving inland from the ocean cools as it hits the mountains. The cooling air condenses into clouds and mist, and as it continues to cool it reaches a critical point where it must release the moisture in the form of rain or snow. Our mountain cloud forests are covered in moss, which act like nets or sponges. The moss captures the mist, enabling the water to drip down into the soil where it can be used by plants or run-off into streams. Due to Hawaii's porous volcanic rock there are few above ground collection points, such as ponds or lakes, causing most of the rain to quickly drain through porous ground to underground aquifers (underground pools of freshwater) and eventually to the ocean. Aquifers are increasingly strained by human development throughout the state, meaning healthy forests and Hawaii's watersheds are becoming more important!

Procedure

1. INTRODUCE LETTUCE
    a. Call the students to the rug.

b. You might start off by eating a healthy salad, passing out snacks made from a slice of cheese wrapped in a lettuce leaf, or just passing around some different kinds of lettuce, and asking how they are different from the brassica plants grown earlier.
c. The students have been developing their gardening and plant-part identification skills, and will guess right away that this is what they are going to plant next.

2. EXPLAIN THE PROCEDURE
   a. Explain to the students that a lot of lettuce is grown in greenhouses these days, and that it might be nice to try a classroom greenhouse.
   b. Since you can't build one in the school yard, you're going to make a mini one, right here in the classroom, using ziplock bags!

3. DEMONTRATE THE PLANTING PROCEDURE
   a. Take out a ziplock bag, and label it with your name.
   b. Open the bag and ask another student to hold it open for you over the bin of soil.
   c. Place a handful of damp soil into the bag.
   d. Take a small pinch of lettuce seeds and sprinkle it loosely across the top of the soil. If any students drop their seeds in a clump, they can spread them out with a fingertip. The seeds do not need to be buried.
   e. Without squishing all the air out, seal the bag tightly.
   f. Make a sketch and write down a few observations in your journal.
   g. *Optional:* weigh the bag, and record name and weight on one sheet of paper to be kept by the scale. This part of the activity will show that the weight (mass) does not change: no water is lost from the sealed bag, and no weight is gained, even though the plants are getting bigger. The water is "locked in" to the cycle.
   h. Tape the ziplock bag to the window.

4. CONDUCT THE ACTIVITY
   a. You may want to have the students work in groups.
   b. Circulate among the students to ask and answer questions, etc.

5. COLLECT (AND WEIGH, optional) THE BAGS
   a. Have students bring bags to the window group by group to tape into the greenhouse.
   b. Use this time to ask questions and encourage predictions about the activity.
   c. OPTIONAL: If you will be having the children weigh their bags, show them how to use the scale, and where to record their data.

6. OBSERVE THE GREENHOUSES IN 6-7 DAYS
   a. By late afternoon, if you have a sunny window, condensation may appear on the ziplock bags. If the students notice it, act very mysterious about it. Ideally, you want to wait a few days for the lettuce seedlings to emerge before you discuss.
   b. Lettuce seedlings should emerge in 6-7 days.
   c. When most of the bags have seedlings, have the students make observations. Take the bags down and hand them back to students to fill out their observation sheets.
   d. Only when the students bring up the "steam" on the sides of the bag should you introduce the water cycle as the purpose of the activity. Ask the students where the condensation

came from (the wet soil). Did they notice that they haven't had to water their lettuce? Why not?

e. Students might notice that as they handle the bags, the condensation rolls back down to the soil. This is analogous to precipitation—moisture that falls to earth in any form.
f. The water is trapped in the bag, so it evaporates, condenses, and precipitates—the entire water cycle—right there in the bag. What else is going through a cycle in the bag? [air is being converted from CO2 to O2 by the tiny plants, and the lettuce is living out the stages of germination and growth in its life cycle].
g. End the observation by asking the students to gently flick most of their water off the sides of their bags and back into the soil. The next day, students can observe whether it has returned. How did it do that?
h. Informally observe the bags every other day or so, and discuss the student's ideas about the water cycle.

7. WATER CYCLE ENERGIZER

Too many droopy eyes in the classroom? Try this easy stretch as an exit pass/energizer: Stand with feet apart. Bend down to touch your toes (pretend they are plants at your feet). Straiten up, stretching your arms high into the air as you say "evaporation!" Wave your hands around saying "condensation!" Sprinkle your fingers like raindrops as you return to touch your toes, saying "precipitation!" Repeat 3-4 times. It sounds silly, but the kids really get into it, and it helps with learning those long words!

8. MINI REPORT

Once the students have been able to observe their lettuce a few times, ask them to write a report. The last section of the worksheet is a format for a mini-science report, with a section for methods ("we planted…), observations (we observed…), conclusions (we found out that…), and reflection (we wonder…). Students should work on their report in the classroom where they can gather with their group about their conclusions and ideas. See the attached teacher's copy for scoring.

9. TO THE GARDEN!

Students can take their lettuce home to plant or add to the school garden. See extensions for a way to plant the lettuce into bottles in a simple hydroponic system.

Assessments

Report assessment should reflect whether students accurately reported real observations, made use of new vocabulary, and made reasonable conclusions and reflections. See the "Teacher Scoring" copy of worksheet below.

Alternatively, print out any of the worksheets at http://www.kidzone.ws/water/ and use these as assessments.

Resources

Lyn Imamura, Waikoloa Elementary Teacher

There are many water cycle diagrams and activities on the Internet. Try www.play_with_water.ch

This is a Hawaiian explanation of the water cycle on an island: http://www.hawaiihistory.org/index.cfm?fuseaction=ig.page&PageID=365

Here is the Hawaii Board of Water Supply animated diagram: http://www.hbws.org/cssweb/display.cfm?sid=1093

Extension Activities

Why Is There No Rain On Kaho`olawe? History tells us that a cloud bridge once connected the formerly green island of Kahoolawe to the verdant slopes of Haleakalā. Herds of grazing deer, sheep, cattle, and goats stripped vegetation from both areas, leaving them dusty and dry. Great volumes of water vapor that used to transpire (evaporate) from the leaves of the vegetation were lost—maybe permanently. The cooling effect of the plant cover helped contain much of the water vapor that evaporated from the ocean. Now that all the vegetation was eaten by non-native animals Kaho'olawe is dry. No vegetation = no water vapor = no clouds = no rain.

So how can you demonstrate transpiration to children when water vapor is invisible? Baggies! Give each child a baggie and a twist-tie (the actual brand "baggies" come with the ties, so you can really capture the water). Head out to a spot in the schoolyard with different kinds of plants early in the morning and have each child choose a leafy branch or a clump of grass (you will need a lot of grass) to bag. Check that the bag is sealed tightly. You can have the students work in groups to find different situations for comparison, or just work on their own. Most of the bags should be in a sunny location, but it's ok if some are not—they will usually collect less water and that can be good as a comparison. Come back during the last period of the day to observe the bags. Have you collected any water? If you have a sensitive enough scale, carefully remove the bags and weigh them in the classroom. Which ones had the most water? The least? Why? [Bags with more leaves or larger leaves in the sun will have most—if no water collected, try again the next day, but water the plants first!]. You can leave the bags on for a number of days and see if the water is taken back by the plants, or if it just keeps accumulating.

Hydroponic lettuce in a bottle (by Sierra Tobiason): Who knew hydroponic lettuce could be so easy? Save a large juice or water bottle with a 1.5 inch opening. Visit a garden store to pick up a matching "dibble tube" or "net pot" with a slightly larger opening on the top, and a small bottle of liquid fertilizer for hydroponics. Fill the bottle with water and a proper dilution of liquid fertilizer. Fill the dibble tube with potting media (soil, fine cinder, Perlite, even aquarium pebbles). Carefully pull a lettuce seedling from its baggie, making sure to handle only the leaves not the stem. Make a little hole and secure the plant in the potting medium. Place the tube in the water bottle, and set in a sunny location for six weeks. When the lettuce is fully grown make a salad!

Literature Connections

The Magic School Bus Wet All Over: A Book About the Water Cycle, by Patricia Relf

Math Connections

Practice weighing your plants at the start and finish of the experiment, and subtract the results to find the change (or lack thereof) using the included Data Table (subtract the end weight from the starting weight). You can also weight the water collected in the baggies in Extension Activity 1.

Lettuce Observation Worksheet Teacher's Copy

Partnership for Reform through Investigative Science and Mathematics

Tell about your observations:

It has been ___ days since we planted our lettuce seeds.

This is what my green house looked like when I observed it:

Should show water droplets, leaves, soil. Each item should be labeled.

I noticed: (should mention growth and changes in the water droplets appearance)

I think that: (should offer some explanation for what is happening with the water)_____

This is what happened when we planted a lettuce greenhouse:

1. We planted…
   Explains what was planted and how .

2. We observed…
   Describes what occurred using vocabulary words appropriately.

3. We found out that…
   Describes a relationship between the water and plant growth.

4. We now wonder…
   Poses any relevant question about the experiment.

Data Table: Greenhouse Weight

Name	Weight on Day 1	Weight at end	Change in weight

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