Unit: Water Cycle, Grade 5

Transpiration Lab
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Intro: A major part of the water cycle is the transpiration of ground water from the soil, through plants, and into the air. This lesson is designed for students to visualize and measure transpiration through plants, and compare transpiration (overall or transpiration rate) to evaporation.

The activity began a class or two after introduction to the water cycle so students were familiar with the definition of transpiration.

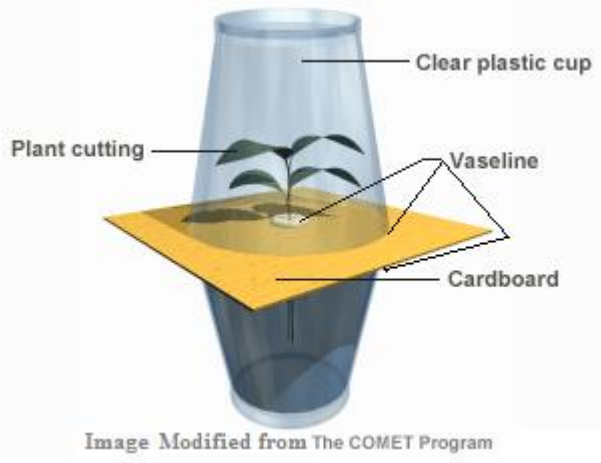
Preliminary setup:

1) I cut 8-10" branches from the tips of 2 different bushes and brought the cuttings into the class. The differences between the bushes were clear as one had very wide leaves and the other had very thin leaves. The stems were about 1/4-1/2" in diameter.
2) I filled clear plastic cups 1/2 way with water and marked the water line with a sharpie.
3) I cut cardboard squares that were large enough to cover the top of the cups, and cut a 1" hole in the center of each piece.
4) I had petroleum jelly available for assembly.

ENGAGE:
We began with a class discussion of the following questions:
How much transpiration really occurs?
Does more water move into the atmosphere through transpiration than evaporation alone?
Do different types of plants differ in the amount of water they transpire?

Students were able to choose which type of plant they wanted to use in their experiment (about half of the class used each type of bush). Students gathered their materials: plant, cup of water, cardboard, empty cup and went back to their desks.

Next, we decided which questions we would test in our experiment.
1) Can we measure how much transpiration occurs?
2) Will the amount of transpiration differ between plants with wide leaves and plants with skinny leaves?



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After the students wrote these questions in their research experiment notebooks we assembled our transpiration experiment. The water cup was placed on the desk, and petroleum jelly was applied liberally to the rim of the cup and the underside of the cardboard to seal it from air-leaks. Then the plant was placed into the hole in the cardboard. The empty clear plastic cup was placed on top, and the edges were sealed with petroleum jelly.

While some students finished their assembly quicker than others, I had extra cups of water for them to assemble our negative controls. These were simply identical setups that did not have any plants so we could measure the rate of evaporation alone.

Students drew diagrams of their setups in their notebooks.
Finally, we placed the assembled cups near the window.

EXPLORE:
THE NEXT DAY we looked at our experiment and found that condensation had formed in the top cups ONLY for the assemblies that contained plants!! There was no condensation formed in the top of our assemblies that didn't contain plants. Students recorded their observations in their notebooks.

Students were asked why there was condensation in some of the top cups but not others. As a class they concluded that indeed we could see transpiration occur, but not evaporation! (This matched our observations)

We removed the top cup and checked them 2 weeks later.

TWO WEEKS LATER each student grabbed their assemblies and brought them to their desks. Then we setup our data chart with three columns, one for wide leaves, one for thin leaves, and one for no plant. Each student got out their ruler and I explained to them how to use it to measure. We measured the distance from the line where the water had started and the current water level. We decided to make our measurements in inches. It turned out that the students did not know how to read a ruler, even after a short lesson, so I went around to each student and helped them read their measurement while other students wrote our readings on the board.

I measured the negative controls for them.

We then averaged each column to determine the values of water loss.

Finally, we subtracted our values for the negative controls from the setups that contained plants to calculate transpiration.

EXPLAIN: As a class we discussed how our average values answered our research questions. I asked them which setup had the highest transpiration and we discussed the differences between our values. We discussed possible explanations for our results including difference in density of stomata (the holes plants use to breath), stem diameter, and number of leaves. We also discussed the differences between our setups with plants (Transpiration + Evaporation) and our negative controls (Evaporation only).

ELABORATE: In our discussion of experimental results we brought the concept of transpiration back into the water cycle. Since we saw higher rates of transpiration vs. evaporation alone, transpiration must be important to the water cycle. We discussed what would be different if the plants were removed from an area and how that might change the water cycle.

EVALUATE: Students were evaluated throughout this study on their ability to make observations and valid conclusions that followed. By the end of the study the class agreed that transpiration was a more important part of the water cycle than they had thought at the beginning. By the end students were able to explain transpiration in more detail and how it fits into the water cycle.