Grade Level: Sixth

Piagetian Level: Concrete/Formal

Learners at the concrete operations stage of development with emerging formal operations are suited for this activity.

STEM *Science, Technology, Engineering, & Mathematics*

Learn & Grow Educational Series℠

Conserving Water

Instructional Goal: Following instruction, students will demonstrate an understanding of water consumption rates and the factors that can cause them to vary from one fruit and vegetable growing context to another.

Lines of Inquiry:

- *How much water is used on average in home gardening in the students' local area?*
- *How much water is used on average in commercial farming in the students' local area?*
- *How much water is used in a self-watering bucket container over a 6-week period compared to average rates of home gardening and commercial farming water consumption in the students' local area?*

Materials:

Assignment 1 -

- *Research & reference tools & materials*
- *Tools & materials to produce the assigned work product, whether it is a written report, PowerPoint® presentation, video, poster, or some other method of demonstrating mastery of the instructed concepts*

Assignment 2 -

- *Research & reference tools & materials*
- *Materials to build one self-watering container for each student (see our instructions for building the containers at http://learn-and-grow.org - it is strongly recommended that the pieces be pre-cut and -drilled by adults or students in a shop class under shop teacher supervision)*
- *Soil, plants, and water for each self-watering container*
- *Appropriate clothing & safety equipment (safety glasses, closed-toe shoes, clothes that can get dirty, etc.)*
- *Printed data collection forms & pens or pencils*

Instructions:

Understanding the importance of

Common Core Standards:

- RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.
- WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- WHST.6-8.8: Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- MP.2: Reason abstractly and quantitatively.
- 6.RP.A.1: Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
- 6.EE.B.6: Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

CA State Standards—Science:

- MS-ES S3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

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Grade: Sixth Piagetian Level: Concrete/Formal

Conserving Water, continued...

water conservation is a critical aspect of the sixth grade standards for science. This lesson plan speaks specifically to the need to instruct students in applying scientific principles to design a method for minimizing a human impact on the environment. The human impact addressed by this lesson is water consumption for food production purposes. The scientific principles to be applied are primarily those from plant biology, hydrogeology, and materials science.

The first component of this lesson is to instruct your students regarding the matter of human impact, that being water consumption for food production.

Assignment 1: Have your students research a variety of sources to find current data regarding how many gallons of water per day are used for commercial farming and traditional home gardening in your local area. Have them prepare written reports, PowerPoint® presentations, videos, poster boards, or other work products that demonstrate their understanding of water consumption rates for home and commercial agriculture in your area (or nearby area).

For the purpose of this lesson, "your local area" is the area within a 100-mile radius of your location. You can use Google Maps or a similar online resource to identify your local area. If there is no local farming in your area, look to the nearest area where commercial farming is conducted relative to your location. You may find it necessary to expand your search to include the entire state if you cannot get enough data regarding local water consumption rates.

Some websites to consider:

- http://www.oecdobserver.org/news/archivestory.php/aid/1801/Water_and_farms:_Towards_sustainable_use.html
- http://www.nationalatlas.gov/mld/wu2000t.html
- http://nhd.usgs.gov/

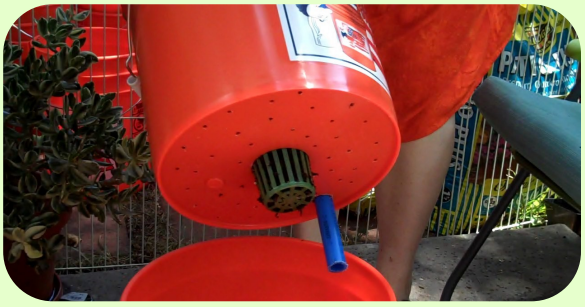
The next step is to research the science of self-watering containers. The process relies upon capillary action within the soil to wick water up from the reservoir of the self-watering container into the soil of the growing bucket above it, while allowing excess water to drain back into the reservoir from the growing bucket through the force of gravity. This means the soil in your containers can't be too dense.

Assignment 2: Have your students research a variety of sources for information regarding capillary action in soil and the soil conditions that are most likely to promote capillary action in their self-watering containers. This is for their own edification, only. They will be expected to apply this understanding during the following project-based learning (PBL) activity.

Then have your students construct self-watering containers (see http://learn-and-grow.org for instructions). DO NOT FILL YOUR CONTAINERS WITH WATER RIGHT AWAY!

You may choose to pre-cut the parts for your self-watering containers or, if in a school with a shop class, have the shop students pre-cut them for your science students. Otherwise, you may need to devote one instruction day to cutting the materials and another construction day to assembling, filling, and planting them. Use appropriate safety precautions for all hands-on activities.

For this assignment, your students will need to measure the rate at which the water is used in their self-watering containers, which requires them to measure the water in the reservoirs of their containers at baseline and again three days later. **It is very important that you are using buckets that are easily separated in your self-watering containers.** The only way to measure how much



water is in the reservoir is to pull out the upper bucket and set it safely aside, then measure the contents of the reservoir in a large graduated container, record the volume measurement, return the contents to the reservoir, and place the upper bucket back into the reservoir bucket. This isn't

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Conserving Water, continued...

difficult unless you have buckets that stick together when you try to pull them apart.

Instructions to Students:

For your baseline measurement, remove your planted upper bucket and safely set it aside, making sure that the drain does not get shoved up into the bottom of the bucket or that the pipe doesn't become dislodged (it can be terribly difficult to get the pipe back in from the top if it gets pulled out; you are better replacing the pipe from the underside of the bucket if it's come out).

Fill your reservoir bucket to the level of the weep hole with water. Using a large graduated container, such as a 3-gallon beaker, pour the water from the reservoir into the graduated container. Record the measurement of volume in your data table.

Return the water to your reservoir bucket and place the planted upper bucket back down into the reservoir bucket. Place your planted container in your classroom garden and clean up your work area.

In three days, **without having added any water to the containers during that time**, your students will again measure the volumes of their individual container reservoirs. It will be a bit messier measuring the liquid in their reservoirs at this point as particles from the soil in the upper bucket will have fallen in through the drain and been brought down by the drainage action of the self-watering process.

The water will be dirty. The process will be a bit cumbersome, as well, so encourage your students to help each other out.

Over time, roots from the plants in the upper bucket may grow down far enough to dangle down through the drain directly into the water. When removing the upper bucket for the second data collection, your students should take care to protect any dangling roots.

The remaining water in the reservoir is measured by removing the upper bucket and placing it safely aside, pouring the reservoir contents into a large graduated container, measuring and recording the volume, returning the liquid to the reservoir, replacing the upper bucket, and returning the container to its designated location.

At the end of the three days, have your students calculate the rate at which their individual buckets lost water over the six-week period using their instructions and data sheets. Then have them average their individual outcomes to arrive at a whole-class, and thus whole-garden, mean rate of water loss.

Have your students compare the amount of water necessary to supply the plants in their garden compared to the water consumption rates for the same number of plants in a commercial or traditional home garden in your area.

Have your students prepare a single, collaborative media project that illustrates their data regarding their classroom average water consumption rates in their self-watering container garden compared to local commercial and traditional home gardening approaches. It can be a bulletin board, poster board, PowerPoint presentation, video, or live presentation.

Take photos of their work product if it is in a tangible format and videos of any live presentations for students' portfolios. Following their presentations of their work products, have your students discuss as a group the impressions made upon them by the lesson.

Prompt them with questions such as:

- Which method of water usage used less water per plant?
- What is the human impact of water usage when it comes to food production?
- What other ways might people grow food using the least amount of water?

Look back to the instructional goal described at the beginning of this lesson plan and the outcomes pursued by the Standards on which it is based. Ask questions of your students that facilitate their understanding of the concepts pursued by the instructional goal of this lesson plan and is related Standards.

Where possible, children should be encouraged to eat the fruits and vegetables they grow in order to make the cognitive connections between growing food, where food comes from, how food provides fuel to the human body, and how healthy foods make a difference in how the mind and body feel and work. This also gives them a sense of empowerment and control over their environments that encourages their intrinsic motivation to eat healthy foods.

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Grade: Sixth Piagetian Level: Concrete/Formal

Conserving Water — Assignment 2 Student Instruction & Data Sheet

Name: _____

For your baseline measurement, remove your planted upper bucket and safely set it aside, making sure that the drain does not get shoved up into the bottom of the bucket or that the pipe doesn't become dislodged (it can be terribly difficult to get the pipe back in from the top if it gets pulled out; you are better going in with the pipe from the underside of the bucket if it's come out).

Fill your reservoir bucket to the level of the weep hole with water. Using a large graduated container, such as a 3-gallon beaker, pour the water from the reservoir into the graduated container. Record the measurement of volume in your data table.

Return the water to your reservoir bucket and place the planted upper bucket back down into the reservoir bucket. Place your planted container in your classroom garden and clean up your work area.

In three days, remove the upper bucket and safely set it aside, measure the contents of your reservoir (it will be full of dirty water by this point), record your measurements, and put your container back together and back in its place.

DO NOT ADD WATER TO THE RESERVOIR OF YOUR CONTAINER OVER THE SAME SIX-WEEK PERIOD THAT YOU ARE MEASURING THE VOLUME OF ITS CONTENTS. THIS WOULD DEFEAT THE PURPOSE OF THE EXPERIMENT.

At the end of the six-week data-collection and recording period, calculate the rate at which *your* self-watering bucket container lost water.

_____		_____		_____
Starting Volume	-	Ending Volume	=	Amount Lost

_____ (1st date measured) _____ (2nd date measured)

Calculate how much water was used per week in *your* self-watering container.

_____			_____
Amount Used	/ 3 days	=	Avg Usage per Week

Class Average Water Usage per Week:

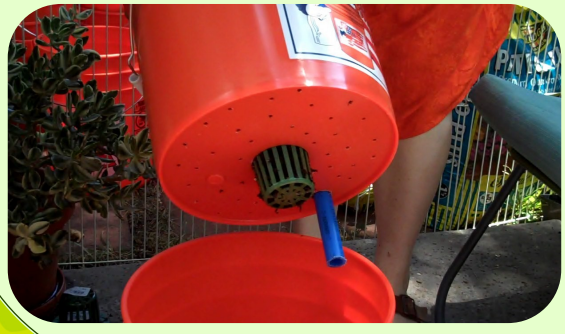
_____

Local Average Water Usage for Equal In-Ground Home Garden:

_____

Local Average Water Usage for Equal In-Ground Commercial Farm:

_____



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