4-H SCIENCE BLAST! IN THE CLASS

Water Quality Experiment

Key Concepts:
- Plant growth
- The scientific process

Grade Level: 4-7

Education Subject: Science

Success Indicator:
In completing this lesson, learners will:
- Conduct a science experiment from beginning to end and draw conclusions based on their data.
- Make accurate measurements of bean growth.
- Evaluate differences in germination and seedling growth.
- Suggest reasons for differences in germination and growth related to the watering solutions.
- Recommend and design follow-up experiments.

Materials and Methods

Preparation Time: 30 minutes

Lesson Time:
- Initial experiment set-up: 30 minutes
- Weekly for three weeks: 10 minutes
- Final measurement: 10 minutes
- Experiment wrap-up: 30 minutes

Space:
- Classroom for set-up and measuring
- Window space or greenhouse space to grow the plants, if available

Materials:
- Five 4-inch plastic plant containers
- Potting soil
- Bean seeds (three per plant container)
- Five plastic milk jugs or other water jugs with lids that can be closed (to prevent evaporation of the water and either loss or concentration of the poor quality water solutions) and labeled
- Permanent marker
- Four different watering solutions and plain tap water
- Rulers with measurements in centimeters (one per group)
- Growth chart handout (one per group plus one for the control container)
- Pencils or pens

Introduction:

Water is a precious, limited natural resource on our planet. We need to conserve water — especially fresh water — wherever we can. One common way to save water is to water plants with water that isn't clean enough for humans to drink. If we do that, will plants grow at the same rates? Will we still be able to produce food crops if we irrigate them with poor quality water?

MICHIGAN STATE UNIVERSITY | Extension

Developed by Norm Lownds, Ph.D., Curator, Michigan 4-H Children's Garden

Instructions:

Preparation time:

1. Read the lesson and gather the supplies from the materials list.
2. Label the water jugs to indicate the poor quality water they will contain. (Common poor quality waters could be pond, lake, river water, salt water, chlorine water.) Label one jug "tap water."
3. Fill all of the water jugs with the appropriate poor quality water. (Note: You may have to prepare some of the poor quality waters by adding appropriate "contaminants" to the jug. You may have to prepare new solutions of poor quality water a couple of times over the course of the three-week experiment.)
4. Leave one poor quality water for the learners to brainstorm and vote on. (Note: The final poor quality water could be anything: rain-water, vitamin water, coffee, cola, Mountain Dew, etc.. Let the kids be creative and have some fun with this.)
5. Recreate and make one photocopy per learner of the growth chart handout.

Lesson time:

Tell the learners they're going to investigate the effect of using poor quality water to irrigate crops. Read aloud or paraphrase the following:

Vocabulary:

Water quality – The physical, chemical and biological characteristics of water. It is a measure of the condition of water relative to its use for any human need or purpose. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water.

Seed germination – The process by which a plant emerges from a seed and begins growth.

Science process/scientific practice – A process or practice that includes a question, research, hypothesis, testing the hypothesis, data collection and explanation of the data collected.

Hypothesis – An educated guess.

For seeds to germinate and grow, they must be exposed to the proper conditions. Most importantly, water must get into the seed to begin all of the processes necessary for germination and seedling growth. Poor quality water (high salt content, polluted, very acidic) could prevent seed germination, and then there would be no seedling growth.

Plants (seeds) are usually watered with the same water that humans use for drinking. However, as there are more and more people, and as some water sources become poor quality – contaminated by industrial pollutants, sewage, excess fertilizer runoff and other factors – we may have to water plants with lower quality water. This raises lots of questions about how lower quality water may affect seed germination and seedling growth:

- *How salty can the water be?*
- *How acidic can the water be?*
- *How much pollution can be in the water?*
- *Can we use pond or lake water to irrigate crops without damaging the watery ecosystems?*

Ideally, we would have answers to these questions before we need them, so that if we are faced with having to grow plants with lower quality water, we know what the limits are, how to use these waters and what to expect in seed germination rates and plant growth rates.

That is the basis for this experiment. It will take a group of collaborating scientists (like you) to answer these questions so that we are prepared for problems that we may have to face in the future. Thanks in advance for your careful work on this important question.

Starting the experiment:

1. Have the learners brainstorm possible watering solutions or contaminants that they might use to water the plants. List these on the board and take a few minutes to discuss why we would or would not use some of these. (For instance, milk is often suggested, but we wouldn't use it because it will start to rot and stink up the whole room). Remove the solutions that you will not use from the list.
2. Have learners vote on the one solution to add to the experiment. Have them look over the list that you could test, select their favorite and put their heads down on their desks, and then read each option off and have those who want that one raise their hands. Record the votes to determine the top option.
3. Divide the class into four groups and have them decide on group names. Then randomly assign one group to each of the four watering solutions. Give each group one plant container and have them label it with their group name and the name of the watering solution they've been assigned, then fill the container with potting soil.
4. Explain that you're going to run the "control" for the experiment. You'll plant the same number of the same kind of seeds in a container the same size as the ones they'll use and filled with the same soil as the experimental containers. The only difference will be that you'll water the control beans with plain tap water. That way they can watch for any differences in how their plants (which they'll water with lower quality water) will grow compared with plants watered with clean drinking water.
5. Next give each group three bean seeds. Encourage the learners to examine the beans carefully and record their observations. Tell

them to plant the bean seeds by pushing them into the soil about 1/2 inch deep, then have them moisten the soil with tap water.

6. Tell the groups to carefully move their plant containers to the growing site you've arranged (such as a windowsill, a shelf under artificial lighting or a greenhouse). Be sure to set the control container with the experimental plants so they're all growing under the same conditions.
7. Discuss with the learners what effect they predict the various watering solutions will have on the plants.

Daily:

Remind the groups to water their plants lightly with the assigned watering solution every day. Remember to water the control container daily, too.

Weekly for three weeks:

Have the learners count the number of seeds that have germinated (sprouted) in their group's container and measure the height of each seedling, then record the results on their group's growth chart. Ask for a volunteer to do the same for the control container.

Final data collection/evaluation:

1. Have the groups take final plant germination and growth measurements and record their results.
2. Next create a grid on the board or on newsprint. Have the groups take turns reporting which watering solution their group used and their plant germination and growth results. Fill in the groups' (including the control container's) data on the grid. Discuss the results with the class.

Check for Understanding:

Ask the group the following questions:

- Do the data support your hypothesis about plant growth? Why?
- Which watering solution grew the fewest beans? Why do you think this happened?
- Which watering solution grew the smallest beans? Why do you think this happened?
- What other differences (besides size and number of plants) did you notice among the containers of beans?
- What water treatment would you recommend for growing bean plants?
- What new questions do you have about this water quality experiment?
- What should the next water quality experiment be?

Option:

- Enter all of the learner data into a Google docs spreadsheet and create germination and growth graphs.
- Link the spreadsheet with a Wikispaces template to present and explain the data, write up conclusions and make recommendations for future experiments. (**Note:** Contact Dr. Norm Lownds at *lownds@msu.edu* to set up this option through the Collaborating Classrooms program of the Michigan 4-H Children's Gardens at Michigan State University.)

Ways to Extend:

- Evaluate other watering solutions.
- Use different seeds for the experiment.
- Do some research on water quality in various parts of the world.
- Do some research to find crops that are being developed to grow under poor conditions, especially conditions of high soil or water salinity (saltiness)

Michigan Grade Level Content Expectations:

Grades 4-5: Demonstrate scientific concepts through various illustrations, performances, models, exhibits and activities (S.RS.04.11, S.RS.05.15).

Grades 5-7: Evaluate data, claims and personal knowledge through collaborative science discourse (S.IA.05.12, S.IA.06.12, S.IA.07.12).

Grades 4-7: Generate questions based on observations (S.IP.04.12, S.IP.05.11, S.IP.06.11, S.IP.07.11); plan/design and conduct investigations (S.IP.04.13, S.IP.05.12, S.IP.05.12, S.IP.06.12, S.IP.07.12); manipulate simple tools that aid observation and data collection/use tools and equipment appropriate to scientific investigations (S.IP.04.14, S.IP.05.13, S.IP.06.13, S.IP.07.13); communicate and present/defend findings of observations and investigations (S.IA.04.13, S.IA.05.13, S.IA.06.13, S.IA.07.13).

Grade 4: Share ideas about science through purposeful conversation (S.IA.04.12); make accurate measurements with appropriate units for the measurement tool (S.IP.04.15); determine that plants require air, water, light, and a source of energy and building material for growth and repair (L.OL.04.15).

Grade 6: Identify the factors in an ecosystem that influence changes in population size (L.EC.06.32).

Grade 7: Describe the origins of pollution in the atmosphere, geosphere and hydrosphere (car exhaust, industrial emissions, acid rain and natural sources), and how pollution impacts habitats and climatic change, and threatens or endangers species (E.ES.07.42).

Growth Chart

My name:	Planting date:
Group name:	Watering solution:

WEEK 1 DATA Date:	WEEK 2 DATA Date:	WEEK 3 DATA Date:	FINAL DATA Date:
Number of plants germinated: ❐ 1 ❐ 2 ❐ 3	Number of plants germinated: ❐ 1 ❐ 2 ❐ 3	Number of plants germinated: ❐ 1 ❐ 2 ❐ 3	Number of plants germinated: ❐ 1 ❐ 2 ❐ 3
Plant heights (in cm): Plant 1: ___________ Plant 2: ___________ Plant 3: ___________	Plant heights (in cm): Plant 1: ___________ Plant 2: ___________ Plant 3: ___________	Plant heights (in cm): Plant 1: ___________ Plant 2: ___________ Plant 3: ___________	Plant heights (in cm): Plant 1: ___________ Plant 2: ___________ Plant 3: ___________
Notes on our group's plants:	Notes on our group's plants:	Notes on our group's plants:	Notes on our group's plants: