April 2021

Lesson Plan: Water Quality and Public Health

Center for Urban Resilience

LESSON 3: WATER QUALITY AND PUBLIC HEALTH

OVERVIEW:

The purpose of this lesson is to explore how water quality affects human health. The importance of this issue has led to the separation of drinking water from wastewater in most developed countries. When potable water is not separated from other types of water, the risk of disease and infection from microorganisms and toxic chemicals increases. Students will learn about common contaminants found in untreated water and explore ways that the water can be made potable. Students will participate in an activity to create a water filter prototype and test its effectiveness.

SUB-QUESTION:

What is the simplest way to provide potable water to the most people?

WAYS OF KNOWING URBAN ECOLOGY:

	Students will…
Understand	• Understand the relationships between water quality and human health. *(ecosystem change, ecosystem state and structure, forces and drivers, human impact)*
Talk	*No specific goals connected with talking urban ecology in this lesson.*
Do	• Model methods by which water can be purified. • Select appropriate materials to design a water filter. • Evaluate the effectiveness of their model water filters.
Act	*No specific goals connected with acting on urban ecology in this lesson.*

SAFETY GUIDELINES

While the overall outcome of this lesson is to produce potable water, the water samples produced should not be drunk.

Chemicals are used in the lab portion of this lesson. Please review the following pointers when conducting water quality tests.

- Read all Material Safety Data Sheets (MSDSs) before using the test kits. **If any chemical comes in contact with a person's skin you will need to be prepared to flush that skin with clean water for 15 minutes.**
- Whenever possible, conduct chemical tests in an indoor space with appropriate eyewash equipment.
- Many of the tests can be conducted within the lid of the kits. This will allow for better control of possible spills.
- Caution students to keep all chemicals (and sample water) away from their faces. Students should NEVER directly smell chemicals.
- **Students must wear gloves and goggles at all times** to protect themselves from the chemicals used in the tests.

- Wipe all liquid and powder spills as soon as they occur. (**Always wipe liquid and powder off of tubes and bottles before shaking them.)**
- When shaking and mixing test tubes, be sure to use plastic caps. **Do not use fingers to cover test tubes.**
- Wash hands thoroughly with soap and water after conducting tests.

PREPARATION:

Time:
Three 45-minute class periods

Materials:

Day 1:

Activity 3.1
PowerPoint and projector (or overheads of slides and projector)

Activity 3.2 (Optional)
One computer with internet access for each student group

Day 2:

Activity 3.3
"contaminated" water samples (100 ml per design team)

> "contaminated" water can either be attained through storm drains, rivers, lakes, etc. or can be made in the classroom. The recipe for "contaminated" water can be made by combining 2L rainwater with ¾-1 cup of dirt, ¾-1 cup sand, and ¾-1 cup plant fertilizer and stir very well.

Water Quality test kits
Student Handout: Water Quality Test Results

Activity 3.4
Student Handout: Water Filter Design Plan

Activity 3.5

Filter materials (per design team)

- One mortar and pestle
- One plastic pipette
- 250 ml graduated cylinder
- 250 ml of coarse sand
- 250 ml of fine sand
- 250 ml of activated charcoal
- 250 ml of "contaminated" water (see note)
- 1 foot of one inch PVC pipe

- 1 sq foot of cheesecloth
- 2 small coffee filters
- 3 rubber bands
- 1 sq. foot of nylon netting
- 2 large cotton balls
- 2 iodine tablets or drops
- 1 funnel
- 1 storage container

"contaminated" water samples (100 ml per design team)
Water Quality test kits

Day 3:

Activity 3.6
Water Quality test kits
Student Handout: Water Quality Test Results

PowerPoint and projector (or overheads of slides and projector)

INSTRUCTIONAL SEQUENCE

Activity 3.1: PowerPoint presentation about water quality

1. Inform your students that they will be looking at water quality in more detail.
2. Present the first part of the power point presentation (slides 1-8). Talking points and questions have been suggested in the notes associated with each slide, as well as connections with the Ecosystem Services Model. The presentation should provide students with information to understand and compare water treatment in developed and developing countries. Students will also review the four top water contaminants that affect human health.

Activity 3.2: Water quality WebQuest (Optional)

1. Follow the Teacher Guide for the Peace Corps WebQuest "Water, Sanitation & Health," an inquiry project which looks at issues of water quality and public health in the developing and rapidly urbanizing continent of Africa. The Teacher Guide can be found at: http://www.peacecorps.gov/wws/educators/lessonplans/lesson.cfm?lpid=2563
2. In a wrap-up discussion, ask your students how what they learned through the WebQuest connected to the Ecosystem Services Model. You may distribute the Ecosystems Services Model diagram to remind your students of the different parts of the model.

Activity 3.3: Students test contaminated water

1. Let your students know that they will now be creating a model of an effective water filter.
2. Divide the class into teams of 2 or 3 students per team.
3. Explain to the teams that each team will be responsible for designing an effective water filter, which will be measured by a range of water quality tests. These tests will show how effective the filter is against some of the most common water contaminants. Students may need a review of how to conduct the tests if they have not conducted them before.
4. The students need to run a series of water quality pre-tests on the contaminated water in order to establish a baseline. All students will be using the same water so depending on the time limitations of your classroom you can have each team conduct one test and then share their results with the rest of the class, or have each team conduct all of the tests. Please note that the coliform bacteria test requires a minimum of 24 hour period so this test must be conducted on the first day but the results will not be ready for assessment until the next day.
5. Each team should record all of the results on the student worksheet.

Activity 3.4: Students design water filter

1. Review the Filter Design Rules (slide 9) and distribute Worksheets to each team. Each team should start sketching out their filter plans. Pages 2 and 3 of the student worksheet summarize the key points about water contaminants and water treatment described in the PowerPoint that students can refer to as they create their design.

Activity 3.5: Students build water filter

1. When each team has a general sketch, give the team its filter materials. They then have the rest of the class period to build their filter. As they make changes to their original design, it should be documented on their worksheet.
2. Provide access to the water quality testing kits for students to use throughout their design process. Students should be encouraged to test their water sample as they progress in order to obtain data that may help them adjust their design.

NOTE: Each team needs to produce enough water to conduct a coliform test by the end of the design class period as this test needs to sit overnight.

If time permits and if there is a need, this activity can be conducted over two class periods.

Activity 3.6: Students test water

1. The first part of this period should be used for each team to conduct the range of water quality tests on their filter's water. By the end of this process, each team should have a completed the Water Quality Test Results Worksheet.

2. When all of the teams have completed their tests, compile the results on a larger classroom chart so that the class can compare their results (PowerPoint Slide #12).
3. Ask the class which of the filters were most effective at cleaning the contaminated water. This should be determined by the purest water sample, that had the least amount of phosphates, nitrates, coliform and turbidity (clearest) as well as a pH reading closest to neutral.
4. Have the team(s) with the most effective filters share their filter design. As a class, develop a list of characteristics of a great water filter and write these characteristics on the board.

Concluding the Lesson

1. The second to last slide on the PowerPoint has information about both common treatments that are used both in developing countries as well as by hikers and campers that drink water from streams, etc. This information is in a chart based on the effectiveness on five different treatments. More information about these treatments is on the student handout Water Treatment 411 (Worksheet 2.1.b)
2. The last slide on the PowerPoint shows some of the more innovative ways that engineers and development specialists are coming up with ways to decontaminate water. A large development agency, like the United Nations and USAID (United States Agency for International Development) is placed in the position to decide which way (both the common and the innovative) is the best choice to use in a range of countries and situations. A question that can be discussed in class or addressed in a writing exercise could be:
   If you were in charge of selecting a specific water treatment process, what are the top considerations you would take into account in making your decision?