Topic: Water Testing

http://water.usgs.gov/nasqan/progdocs/factsheets/natfact/natfactsheet.html

Grade 9-Adult

An integrated lesson plan covering one session of approximately 1.5 - 2 hours.

Lesson-Planning Approach

Some learners perceive their “world” as a whole, where all things are interconnected and dependent upon each other. These “integrated” students face major challenges in coping with our dominant educational, social, and economic systems, which tend to present information in a linear fashion without the necessity of integration into meaningful context. Integrated students are at-risk of failing as they attempt to grasp information in ways that do not match their experience. Among large populations of at-risk students are many from Native American and similar cultures who do not regard their world as a sum of parts but as a blend of all that they experience.

This lesson plan does include some traditional, linear approaches to delivering information (checklists, rules, analysis, problem solving and organization). In addition to the traditional, linear delivery of information, this lesson plan also includes some of the following strategies, designed to appeal to at-risk students as they learn academic/life skills:

- Integration of technology
- Story telling/anecdotal information
- Non-competitive group and team work
- Performance-based assessment and rubrics
- Visual presentations and practice through technology and other means
- Project-based assignments that integrate family and community
- Activities appealing to multiple intelligences (Gardner)
- Application of Scientific Method to formulate and solve a problem.

Lesson Overview

This lesson is designed to familiarize students with testing water for hardness, which means the amount of minerals dissolved in the water. Animations and resources are available on the internet. Students will test samples from 3 different sources and quantify the results. From their results, they will write a summary, apply relevant vocabulary, and answer questions about the project using correct punctuation, sentence structure, and experimental method.

Lesson Objectives

Project Objectives: When students complete this session, they will be able to…

- Design and carry out an experiment to test a hypothesis about the dissolved minerals in water.
- Define the main components of water quality.
- Explain the basic chemistry behind the hardness assay
- Hypothesize why a water sample may contain large amounts of dissolved minerals

Integration of Other Functional/Academic Skills: (Critical thinking is required throughout the lesson.) Students will be able to…

Math:	Quantify the amount of EDTA needed to titrate each Water sample and create a scale from least to greatest hardness
Reading:	Apply technical vocabulary; find main points and meaning in written and internet passages.
Writing:	Summarize; define; explain
Listening:	Follow oral instructions when carrying out the experiment
Science	*A*pply scientific method and correctly format an experiment
Technology:	Apply basic features of Microsoft Word and search a site on the Internet

State/National Standards (Complete as Appropriate)

http://www.cde.state.co.us/cdeassess/sci.htm#standards 1,2,5,6
http://www.cde.state.co.us/download/pdf/math.pdf 1,3,5

Required:
http://h2osparc.wq.ncsu.edu/info/hardness.html water hardness defined

Support:
http://wilkes.edu/~eqc/arsenic.htm Testing water for arsenic
http://water.usgs.gov/nasqan/progdocs/factsheets/natfact/natfactsheet.html Water quality in Colorado
http://www.co.blm.gov/mines/upperanimas/upperanimas.htm Water quality studies of the upper animas
http://www.agric.gov.ab.ca/sustain/water/final_wq_guide.html Water quality and agriculture

Pre-requisites: Read at sixth grade level or above.

Required Materials

- Water testing kit (ingredients and directions vary). Try contacting your local water treatment or testing company. They may be able to put together a simple kit. Fish stores or Biological Supply Companies also sell kits.
- At least 3 different water samples and Distilled Water (for baseline)
- Small beakers or cups
- Disposable Pipettes

Handouts (Included at the end of this document)

- Background (Handout 1)
- Experimental Design (Handout 2)
- Lesson Rubric (Handout 3)

Required Equipment/Technology

- 1 computer, with Internet connection and a MS Word for every group of 2-3 students

THE LESSON

Note: Students do not learn from what you do but from what you have them do.

PART I

Preparation

Activity	Instructor Notes
Research the topic.	**Check into water quality issues in your area. Understand Hardness and other measurements of water quality relevant to your area**
Describe and demonstrate the basic procedure	**Assemble the equipment and materials using the correct terminology and cautions for each item. Stress the need for accuracy.**
Examine handouts.	**Go through each handout**

Presentation (Power Point Presetnation)

Observe how to find URL's and navigate relevant sites. Discuss water quality issues in your area, and have students research the meaning of water hardness	**Show students how to use URL addresses. Show students how to look up words and information in http://encarta.msn.com/ , http://dictionary.msn.com/ ,** http://h2osparc.wq.ncsu.edu/info/hardness.html water hardness defined **Have students practice accessing several different URL's with your help.**

Performance and Practice

Instructions for students	**Teacher notes**
Why is water so important? What might be in the water that we can't see?	**Use local examples and questioning**
http://h2osparc.wq.ncsu.edu/info/hardness.html water **hardness defined**	**Go to the link** http://h2osparc.wq.ncsu.edu/info/hardness.html water hardness defined **Help pairs or groups refine and make sense of the information.**
Go through the Power Point presentation and make sure you understand the procedure and what you are testing for.	**Have students underline or note important points from the article**
Do the experiment and record your results.	**Complete the exercise WITH students. Help them arrive at answers. Use the other sites suggested and help students arrive at solutions together.**
Demonstrate understanding by explaining the meaning of hard and soft water. Classify your samples	**Talk about water quality and chlorine**

Lesson Assessment Strategy (Formative – As the lesson progresses)

Preparation, Presentation and Overall Implementation (Instructor)

1. Are the instructions and expectations for the class clear from the beginning?
2. Am I spending sufficient time on modeling the skills I want students to acquire?
3. Is there enough variety in the lesson to appeal to most learning preferences?
4. How many learning intelligences am I addressing?
5. Are students "connecting" to lesson objectives? How?
6. How is this lesson "integrated?"

Performance and Practice (Student)

1. Do all students have the skills to follow instructions? If not, what measures am I taking to address the challenge?
2. Are all students participating in the activities either by active observation or by voicing their thoughts?
3. Am I identifying the strengths of each student and pairing/grouping people accordingly? What results am I getting?
4. How are students performing? Are all of them able meeting 80% of the lesson objectives? If not, what am I doing to help them achieve more?

Technology

1. Is the technology working?
2. How are students reacting to the technology, and what do I need to remember when I teach this lesson again?
3. How are students applying or wanting to apply their technical skills in other areas?

Activity Checklist (Handout 2)

Discuss the topic.	
Handle and examine the test kits	
Examine and discuss handouts.	
Observe how to find URL's and navigate relevant sites.	
Go to the Internet and visit http://h2osparc.wq.ncsu.edu/info/hardness.html water hardness defined Read the article in groups and explain water quality .	
Test the water samples according to the directions	
Record the results	
Discuss and summarize the results.	
Research other links about water	
Discuss possible solutions for water quality issues in your area	

Hardness

General Information: Water hardness is commonly defined as the sum of the polyvalent cations dissolved in the water. The most common such cations are calcium and magnesium, although iron, strontium, and manganese may contribute (AWWA, 1990; EPA, 1986). Hardness is usually reported as an equivalent quantity of calcium carbonate ($CaCO_3$). Generally, waters are classified according to degree of hardness as follows (EPA, 1986):

Concentration $CaCO_3$ (mg/l)	Classification
< 75	soft water
75 - 150	moderately hard
150 - 300	hard
> 300	very hard

Hardness is primarily a function of the geology of the area with which the surface water is associated. Waters underlain by limestone are prone to hard water because rainfall, which is naturally acidic because it contains carbon dioxide gas, continually dissolves the rock and carries the dissolved cations to the water system.

Numerical Categories:

Limits:

Designated Use	**Limit (mg/l $CaCO_3$)**

Industry (raw water source) (EPA, 1986)

Textile	120 max concentration
Pulp and paper	475 max concentration
Chemical	1,000 max concentration
Petroleum	900 max concentration

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Course: Science

Water Testing

Explore how levels of contaminants are measured in water levels

Expectations:

Criteria:	**Level 4** (80% - 100%)	**Level 3** (70% - 79%)	**Level 2** (60% - 69%)	**Level 1** (50% - 59%)
Knowledge				
describe the properties of water	describes the properties of water with excellent knowledge	describes the properties of water with considerable knowledge	describes the properties of water with some knowledge	describes the properties of water with limited knowledge
Experimenting				
identify allowable levels of metallic and organic pollutants in drinking water	identifies allowable levels of metallic and organic pollutants in drinking water with excellent success	identifies allowable levels of metallic and organic pollutants in drinking water with considerable success	identifies allowable levels of metallic and organic pollutants in drinking water with some success	identifies allowable levels of metallic and organic pollutants in drinking water with limited success
Communication				
explain the hardness of water, its consequences, and softening methods	explains the hardness of water, its consequences, and softening methods with complete information	explains the hardness of water, its consequences, and softening methods with good information	explains the hardness of water, its consequences, and softening methods with some information	explains the hardness of water, its consequences, and softening methods with limited information
describe the importance of water	describes the importance of water with thorough reference to use as a universal solvent	describes the importance of water with considerable reference to use as a universal solvent	describes the importance of water with some reference to use as a universal solvent	describes the importance of water with limited reference to use as a universal solvent

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Electric Utilities	5,000 max concentration

Health Effects: Not applicable

Environmental Effects: The effects of hardness on aquatic life is a function of the cations comprising the hardness.

Irrigation Effects: Carbonate deposits may clog pipes and coat the inside of water holding tanks. Extreme hardness may interfere with chemical processes.

Sources:

1. *Nonpoint source:*
    - Natural: The physical weathering of calcium and magnesium strata will contribute cations to surface and ground water.
    - Anthropogenic: Additional sources include discharges of cation-rich waters from operating and abandoned rock quarries (EPA, 1986).
2. *Point source:* Inorganic chemical industry may release dissolved cations in effluent waters (EPA, 1986).

Mode of Transport: Dissolved cations are carried via overland, unsaturated, or saturated flow.

Analytical Techniques:

(APHA, 1992; Nebraska Administrative Code, 1993)

1. **Calculation:** Use following equation to compute hardness from results of separate determinations of Ca and Mg concentrations.

    Hardness, mg equivalent/L $CaCO_3$ = ([Ca,mg/l]*2.497) + ([Mg,mg.l]*4.116)

2. **EDTA Titrimetric Method:** EDTA forms a chelated soluble complex when added to metal cations. Dye added creates a wine-red solution. EDTA added as a titrant complexes with the Ca and Mg. Solution turns blue when all complexed. A pH of 10+/- 0.001 is recommended for sharpest endpoint.
    - *Detection limits:* Varies according to modifications of technique.
    - *Interferences:* Some metal ions interfere: Al, Co, Ni (over 20 mg/l), Cu, and Fe (over 30 mg/l). Suspended or colloidal organic matter may interfere.
