Reading The River Summer 2003

How Clean Is The Water In My Backyard?
High School Biology

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Fall 2003

Lesson Context

This lesson is the culminating activity of an Ecology Unit for a general biology class.

The ecology unit is designed to meet the core content requirements as follows:

Core Content:

Geochemical Cycles

SC-H-2.2.1 Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different reservoirs. Each element on Earth moves along reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.

SC-H-2.2.2 Movement of matter between reservoirs is driven by Earth's internal and external sources of energy. These movements are often accompanied by a change in physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

The Interdependence of Organisms

SC-H-3.5.2 Energy flows through ecosystems in one direction from photosynthetic organisms to herbivores to carnivores and decomposers.

SC-H-3.5.3 Organisms both cooperate and compete in ecosystems. Often changes in one component of an ecosystem will have effects on the entire system that are difficult to predict. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.

SC-H-3.5.4 Living organisms have the capacity to produce populations of infinite size. However, behaviors, environments, and resources influence the size of populations. Models (e.g., mathematical, physical, conceptual) can be used to make predictions about changes in the size or rate of growth of a population.

SC-H-3.5.5 Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.

Matter, Energy, and Organization in Living Systems

SC-H-3.6.1 Living systems require a continuous input of energy to maintain their chemical and physical organization since the universal tendency is toward more disorganized states. The energy for life primarily derives from the Sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing molecules. These molecules can be used to assemble larger molecules (e.g., DNA, proteins, sugars, fats). In addition, the energy stored in the bonds between the atoms can be used as sources of energy for life processes.

SC-H-3.6.3 As matter and energy flow through different organizational levels (e.g., cells, organs, organisms, communities) and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

In addition to the unit meeting the core curriculum requirements listed above, it is also designed to address the program of studies academic expectations as follows:

Students will be able to:

Scientific Inquiry

Identify and refine questions and identify scientific concepts to guide the design of scientific investigations
Design and conduct different kinds of scientific investigations for a wide variety of reasons.
Use equipment (e.g., microscope, lasers), tools (e.g., beakers), techniques (e.g., microscope skills), technology (e.g., computers), and mathematics to improve scientific investigations and communications.
Use evidence, logic, and scientific knowledge to develop and revise scientific explanations and models.
Communicate designs, procedures, and results of scientific investigations.
Review and analyze scientific investigations and explanations of others.

Earth /Space Science

Recognize that the Earth contains a fixed amount of each stable chemical atom or element
Analyze Earth's chemical reservoirs and recognize that each element can exist in several reservoirs.
Investigate how Earth's internal and external sources of energy drive geochemical cycles.

Life Science

Analyze energy flow through ecosystems
Examine interrelationships and interdependencies or organisms in ecosystems and the factors that influence the interactions between organisms.
Explore how human activities alter ecosystems.

The goal of the activity is to take the learning out of the classroom into the student's own neighborhood and to demonstrate that science is relevant to individuals and society tying the concepts learned in class to a "real life" situation.

Ecology Concepts
Week One
Students will be able to:

Identify different levels of organization studied by ecologists.
Individual, population, community, ecosystem, biome, biosphere
Describe methods used to study ecology.
Observing, experimenting, modeling

Identify the source of energy for life processes.
Sunlight or inorganic chemicals
Trace the flow of energy through living systems.
Sun/inorganic chemicals →autotrophs (producers) →heterotrophs (consumers)
Evaluate the efficiency of energy transfer among organisms in an ecosystem.
Ecological pyramids: energy, biomass, and numbers
Describe how matter cycles among the living and nonliving parts of an ecosystem.
Biogeochemical cycles e.g., water cycle
Explain why nutrients are important in living systems.
Nutrient cycles: carbon, nitrogen, phosphorus.
Describe how nutrient availability affects ecosystem productivity.
Limiting nutrients: algal blooms and BOD.

Activity: Enviroscape® demonstration

Week Two

Explain how biotic and abiotic factors influence an ecosystem.
Biotic factors: living portion of the ecosystem such as plants and animals
Abiotic factors: climate, nutrients, soil, sunlight
Habitat and niche.
Identify interactions that occur within communities.
Competition, predation, symbiosis.
Describe how ecosystems recover from a disturbance.
Primary and secondary succession.
Identify the factors that govern aquatic ecosystems.
Depth, flow, temperature, and chemistry of the overlying water.
Identify the two types of freshwater ecosystems.
Flowing water and standing water ecosystems.

Week Three
Lab Activities
How Clean is the Water in My Backyard?

Lab 1 2 class periods
Problem

How to use water quality testing materials/equipment properly.
How to collect and record data.

Materials

LaMotte Testing kits: wide range pH, dissolved O_2
Conductivity probe
Thermometer
Tape measure
Habitat assessment guide
Plankton and macroinvertebrate collection nets
Coliform testing material
Data sheet
Water sample for testing purposes
Pictures for habitat assessment

Procedure

Read through handouts: LaMotte Manual and Stream excerpts.

After instructor demonstration, students working in teams of *4 will practice the use of the LaMotte kits, conductivity probe etc.

Evaluation

Student groups will demonstrate the use of the equipment for the instructor.

After lab is completed and all groups have demonstrated their abilities to correctly use the materials and collect and record data, teams will take home materials and collection of data from home/neighborhood sources will begin.

*Teams will be determined during the first week based on their proximity to each other and/or ability to work together after school.

Lab 2 2 class periods

Problem

How can algae be used as an indicator of water quality?
How can macroinvertebrates be used as indicators of water quality?

Materials

Reading: Identification of Algae in Water Samples CD
Section 1: George Izaguirre
Microscope
Slides, cover slips, Petri dishes
Pipettes

Algae keys, field guides, photos, CD
Prepared slides of identified algae
Water samples

Procedure

Using the pipette, make a wet mount slide from the water sample provided. A petri dish may be used for larger specimens.

Identify as many different specimens of algae, zooplankton, and macroinvertebrates as possible and make detailed drawings of each under high power.

Analysis/Conclusion

1. What kinds of algae did you identify?
2. What does this indicate about the quality of this water source?
3. Were there any macroinvertebrates in your sample? What were they?
4. What kinds of zooplankton did you identify?

Activity: Macroinvertebrate game

Problem

How can macroinvertebrates be used to determine water quality?

At the conclusion of Lab 2, teams that have already collected data and specimens will start identifying the macroinvertebrates and invertebrates found in their water source. Teams who have not, will play the macroinvertebrate game, work with the Enviroscape®, practice skills. Teams will rotate all activities until everyone has completed all. All data should be collected by Monday of week 4.

Week 4

Monday

Data sharing
Discussion of results

Due Friday: Lab report

Each student is responsible for a data sheet with all of the teams' data collected as well as an analysis of the students' team "home" source incorporating all data and explanations as necessary. Recommendations for maintenance, cleaning, improving, or whatever is needed is to be the conclusion of the lab report. Include any pictures, drawings, or videotapes made at the source.

Portfolio Project
Choose one of the following methods to inform some segment of the population about water quality issues.

- A children's book (e.g., coloring book, story book, coloring book)
- A pamphlet or brochure (audience of any age you choose)
- A newspaper or magazine article
- A letter to the editor/editorial about the specific source studied
- Script for play, puppet show etc.
- Lesson/activity for elementary or middle school
- Poem
- Song

The instructor must approve any other method.

Due Friday of week 5: Rough draft of portfolio project
Due Friday of week 6: Final draft of portfolio project

Concepts

Water equals survival. Every part of our lives relies on water. Water makes up 80% of our body weight. Although the same percentage of the Earth's surface is covered by water, only 1% of that is fresh water which can be directly used for domestic, industrial, commercial, and recreational purposes.

We have the same amount of water as we did millions of years ago and, through the water cycle, we continually reuse that same water. Diverse use and increased demand has put enormous stress on our water supply, its quality, and the aquatic life and the habitat it sustains.

Water quality plays an important role in the abundance and diversity of aquatic life. Excessive amounts of algae, nutrients, or suspended particles, or lack of dissolved oxygen can result in imbalances in water chemistry. Episodic or prolonged imbalances can potentially degrade aquatic life enough to harm the food

chain, fishing and recreation industries, and even the air we breathe.

Excerpted from LaMotte The Monitor's Handbook A Reference Guide for Natural Water Monitoring

Human activities affect the supply and quality of all renewable resources, such as water. For example, cattle near a stream may increase the fecal coliform count to unsafe levels. Increased nutrients from fertilizers may result in an algal bloom and decrease the amount of dissolved oxygen available for other organisms. Since the supply of water is limited, protecting water supplies from pollution of any kind and managing the growing demand are major priorities. Monitoring water systems is an important part of management.

It is important that students recognize that one way of protecting water supplies is to protect the natural systems involved in the water cycle and that they can be active stewards in this process. Anyone can follow better management practices no matter where they live. Students must also realize that there are many methods to assess water quality, some of them, such as bioassessment, are very simple to do and do not require expensive special equipment.

Evaluation

In my classes, all labs are graded using the following guidelines:

50% behavior and equipment management

50% accuracy in written portion of the lab. This includes any questions, drawings, data sheets etc.

Lab 1: No written portion, instead, the 50% for that portion will be earned upon demonstration of correct usage.

Lab 2: Analysis and conclusion questions: 10 points each. Detailed drawings properly done: 30 points.

Week 4 lab report: 100 points divided as follows

Data sheet with all teams' data.....25 pts.

Analysis Report of "home source"

Data incorporated.....15 pts.

Data explained .....25 pts.

Recommendations.....25 pts.
Visuals.....10 pts.

Portfolio Project

The evaluation will depend, to some degree, on option chosen. However, students will be instructed on the following areas to cover at 20 points each for a total of 100 points:

- ✓ Ways water is important
- ✓ How water can be polluted/damaged
- ✓ What the effects of poor water quality can be
- ✓ What we can do to prevent/repair water quality problems
- ✓ Colorful, eye-catching, visuals, neat

Testing

Testing at the end of the lecture material may be done to determine how well students have incorporated material.

Works Cited

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