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MINI-UNIT DESIGN
Lesley University
EEDUC 5013
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Unit Description:

This 8-session mini-unit is designed to follow the National Science Education Standards from the grades 5-8 Earth and Space Science "Science as Inquiry" content standards. The lesson activities and expectations are being designed to be taught to a combined 5th and 6th grade class. The description of the class is provided below at the beginning of "Lesson 5". The focus will be from - Content Standard D. "Structure of the Earth System", pages in text: 158-161. Specifically we will examine the Earth as a "water-planet". Students will gain an appreciation that the surface of the Earth is over 70% water, and that greater than 97% of the water is in the oceans. We will learn that even though 0.001% of the water is contained in the atmosphere, that this is significant when we consider natural and human-influenced global climate changes. The mathematics of decimals and percentages will be a very real extension of the unit, and the concept of "powers of ten" will be introduced. The unit will also have extensions into geography and social studies as we consider concepts such as global warming and acid rain.

There will be activities to actively involve the students in their learning, as we begin the unit with inclusive non-competitive games illustrating the components of the water cycle, as described by the FOSS guide. An engaging set of inquiry lab sessions modeling the water cycle are then selected from the STC guide. Students will extend their inquiry with two lessons from the GEMS "Acid Rain" guide.

Names of nationally-validated, Standards-based, STS-based curricula used for this mini-unit:

FOSS Teacher's Guide
Investigation 7: "Weather and Water".
Teachers resource, pages 223-244; and pages 281-320.

"Science and Technology for Children, STC"
Land and Water Teacher's Guide
Smithsonian/The National Academies
Teacher's Resource, pages 23-93.

And, for the "Acid Rain" module:
LHS GEMS "Acid Rain"
Lawrence Hall of Science; University of California at Berkeley.
Teachers Resource, pages 7-38.

This mini-unit is being considered in the context on an overall larger unit which could easily be designed to cover the following content:

Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground. Water runoff from land to bodies of water can also be considered.

- Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.
- The atmosphere is a mixture of gases that include water vapor.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns influence local weather.
- Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

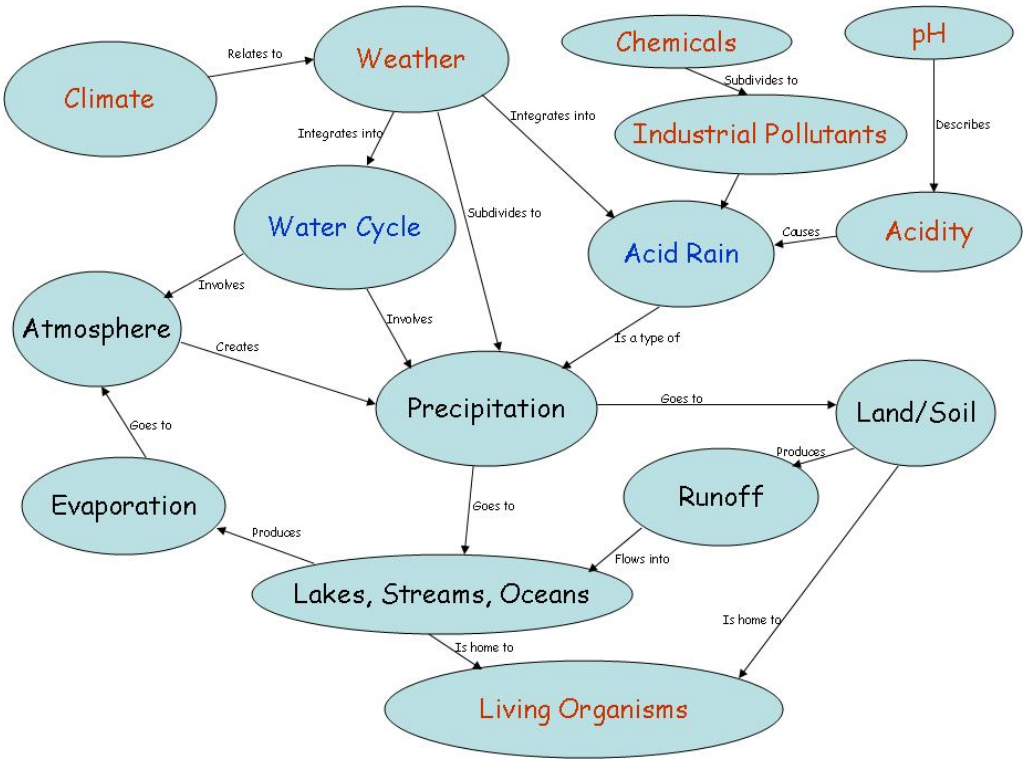
What are the CONCEPT standards addressed by this unit?

Earth Processes and Cycles

Central Concepts: Earth is a dynamic interconnected system. The evolution of Earth has been driven by interactions between the lithosphere, hydrosphere, atmosphere, and biosphere. Over time, the internal motions of Earth have continuously altered the topography and geography of the continents and ocean basins by both constructive and destructive processes.

* Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments, and creates various types of landscapes. Give examples that show the effects of physical and chemical weathering on the environment.
* Explain how water flows into and through a watershed. Explain the roles of aquifers, wells, porosity, permeability, water table, and runoff.
* Describe the processes of the water cycle, including evaporation, condensation, precipitation, surface runoff and groundwater percolation, infiltration, and transpiration.
* Relate earthquakes, volcanic activity, tsunamis, mountain building, and tectonic uplift to plate movements.

CONCEPT MAP:



Key for Concept Map:

Red Font: Likely Pre- and Post- Benchmark Lessons

Blue Font: Key Concepts for This Unit

Massachusetts Frameworks Strand and Learning Standard which are addressed:

Earth and Space Science Learning Standards

Explain how air temperature, moisture, wind speed and direction, and precipitation make up the weather in a particular place and time.

Distinguish among the various forms of precipitation (rain, snow, sleet, and hail), making connections to the weather in a particular place and time.

Describe how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

Differentiate between weather and climate.

Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.

Give examples of how the cycling of water, both in and out of the atmosphere, has an effect on climate.

Brief Description of Students to be Taught:

I will be teaching two sections of the combined 5th and 6th grade at the Fayerweather Street School in Cambridge. This is a small private school of about 350 students ranging from grades Pre-K though 8th. The two 5th/6th grade sections have 11 and 12 students, respectively. There are no IEPs or special needs students in either of these classes. A particular challenge for these activities, and the entire unit, is to provide instruction that is basic enough for the 5th graders, while having challenging enough activities for the more advanced 6th graders. On the other hand, the setup of teaching an inquiry science class which is comprised of both 5th and 6th graders provides an excellent opportunity to allow the students to be directly involved in their own scaffolding.

Structure of the Unit:

This unit is designed to be comprised of eight 50-minute lessons structured to last for a period of two weeks. The flow of this unit is as follows:

Lesson 1: Earth, the Water Planet – Introduction to the Water-Cycle.

Lesson 2: Earth, the Water Planet – Continuation of the Water-Cycle.

Lesson 3: Earth, the Water Planet – The Water-Cycle and Weather

Lesson 4: Modeling Land and Water (Designed as Double-block, or consecutive lessons).

Lesson 5: Let's Learn About Acid Rain

Lesson 6: Modeling "Normal" Rain and Acid Rain on Land (with runoff), and Introduction of the "Culminating Activity"

Lesson 7: Final Observations of the Water Cycle Model, and

Continue work on "Culminating Activity"

Lesson 8: "Culminating Activity": ***Town Meeting: Topic "Acid Rain and Our Community***

Week One (3-5 days of student focused activities)

Activity	the Water Cycle Game	Participatory Demonstration	Discussion and work with multi-media following FOSS Video	Begin creation of Land and Water Model	
At home assignment	FOSS Self-assessment	Readings and being prepared for mini-assessment	Students prepare brief presentations	Find every-day-to-day evidence of scientific concepts	
Concept	The Water Cycle	The Earth is a "Water Planet"	Climate is distinct from weather	We can model the Water Cycle	
Process Skill	Modeling	Observing	Classifying	Modeling	

Lesson 1: Earth, the Water Planet – Introduction to the Water-Cycle.

Using Investigation 7 of the FOSS "Weather and Water Course" teacher's resource, we will begin our inquiry into Earth as a water planet. The goal of this exploration is introduce the concept of the water cycle as a complex system that involves water everywhere in the global environment. In this lesson, students will consider why the Earth is called the water planet. The objectives for this lesson are to in a very fun way demonstrate that water, or an individual water "molecule" (a very small particle of water), could follow many possible different paths as it travels between locations in the water cycle.

We will modify the FOSS investigation by getting the kids involved right away in the Water Cycle Game. In this game the students are in groups of 3 or 4, as water molecules. They each begin their journey at one of nine possible stations; animal, atmosphere, glacier, groundwater, lake, ocean, plant, river, and soil. An interesting addition/twist to this game, if the students are interested is to throw in the Global Warming "wildcard rule", as described in Investigation 9 (pages 315-318 of the teacher's resource).

At the end of the game, time permitting, working independently, the students will begin a brief written self-assessment describing what the learned. They will be expected to have a basic conceptual understanding of what the water cycle is, and how a drop of water could travel through the cycle. The more advanced students will be able to demonstrate relative time periods of the various steps along the cycle. The less advanced students would at this point likely only demonstrate a very rudimentary, over-simplified understanding of the water cycle. They will finish this self-assessment for homework, to be handed in at the start of the next class. Students will also begin their readings from the FOSS booklet "Earth: the Water Planet" for homework.

Preparations needed for this lesson:

1. Water Location posters will need to be photocopied from the FOSS kit. If modifications are made, the posters will need to be prepared ahead of time. The posters will need to be hung at various locations around the room, with consideration of the space requirements to allow simple and efficient movement of the students from station to station around the room.
2. The "Ocean" poster will need to be hung in an open location where students can congregate.
3. Preview the Game tally sheet.
4. Plan a "Pre-Assessment". This will reveal the students' prior understanding of the water cycle to allow assessment of intuitions and misconceptions.

Required materials for this lesson are:

For Each Group:
1 Die
4 "Weather and Water Resources" books (provided in the FOSS kit)
Includes: "Water-Cycle Game Rules"
4 "Weather and Water Lab Notebooks" (provided in the FOSS kit)
Water-Cycle Game, page 43

For The Class:
Globe of the Earth, minimum of 12" in diameter
Chart Paper
A dozen Marking Pens
Water-Cycle Descriptive Poster
9 "Water Location Posters" for the Game Locations
"FOSS Transparency 23, The Water Planet"
"FOSS Transparency 24, Water-Cycle Game Tally"

Lesson 2: Earth, the Water Planet – Continuation of the Water-Cycle.

This lesson will begin with a discussion of the previous day's inquiry. Now that the student's have had the opportunity to independently process the various parts of the water cycle through their homework, we will be able to discuss the Water Cycle Game in richer detail. For example we will look at what the students found surprising about how water moves through the planet's surface, waterways and atmosphere. In what ways is the game similar to the actual water cycle in the real world? In what ways is it different?

The FOSS kit comes with a demonstration that shows how the planet's water is distributed. Through this demonstration, we will consider how the answers that the students gave to the above questions are realistic, or misconceptions. According to the FOSS teacher's resource the teacher

does a demonstration that shows distribution patterns of water on Earth. Students participate in the demonstration at the direction of the teacher. While this exercise may not directly lend itself to be transformed into an inquiry lab, students could work in small groups to determine on their own, or by peer scaffolding, the patterns of water distribution. This demonstration, or ideally lad exercise, will lead to a discussion of the distribution of fresh water, and by extension salt water on the Earth. An inquiry element could be introduced by incorporating salt into the lab. Why is there salt on your tables? What did the students learn from last night's reading assignment?

The concept for this lesson is that most of the Earth's water is salt water found in the oceans, while fresh water is found in many locations – including the atmosphere, lakes, rivers, glaciers, and groundwater. Tonight's homework assignment will be to continue the readings from "Earth: the Water Planet". In preparation for the next lesson, students will be assigned the reading of "Mr. Tornado and Severe Weather".

Preparations needed for this lesson:

1. Review and understand the "Water-Distribution Demonstration"
2. Plan the assigned readings from "Earth: the Water Planet"
3. Consider what misconceptions or understandings the students are likely to have about the water cycle. Consider what leading questions are necessary to assess next students' levels of understanding.

Required materials for this lesson are:

Assuming a teacher-led demonstration (if done by student groups, multiply by the number of groups:

1 1-liter beaker
Water, (~100 ml)
1 pipette
1 graduated cylinder (100ml)
Paper towels
1 100-gram box of table salt (optional)

Lesson 3: Earth, the Water Planet – The Water-Cycle and Weather

Rather than continue with the FOSS curriculum in part 2 of Investigation 7, which is simply a media enhanced recapitulation of the Water-Cycle game, I have decided to use an exploration from Investigation 9 of this same resource. Investigation 9 is dedicated to making the important distinctions between weather and climate. In this lesson we will consider the water cycle, as it relates to weather. We will define weather as the condition of the atmosphere at a specific time and location. We will not take on the concept of climate in detail at this time. If at the end of the unit, there is ample time we will explore climate as the average weather condition over a long period of time in a specific region.

In this lesson students will view and discuss a video entitled "Wonders of Weather". They will define weather and climate, and compare different regions around the world. While, the passive watching of a video pauses the inquiry nature of our lesson, it is important for this unit that the students understand the relationship of water, the water cycle, and weather. We will soon begin a series of explorations in which students will model the water cycle on "land and water". This will ultimately prepare us to examine a uniquely contribution to potentially changing global weather

conditions, acid rain. And, time permitting as an extension to the mini-unit, this also opens the possibility of exploring another human-made change, global warming.

We also will be able to use the FOSS Multimedia CD Rom. Students will work in groups with one computer per group. Students will be assigned to different regions, and will have one member of each group give a brief presentation during the first 10-15 minutes of tomorrow's class.

Preparations needed for this lesson:

1. Review Water Cycle posters, and student assignments.
2. Preview the Videotape. It is 13 minutes long.
3. Plan the use of multimedia: FOSS CD Rom – Climate Regions.

Required materials for this lesson are:

For Each Group of 4 students:
1 Water Cycle poster from Lesson 1
4 "Weather and Water Resources" books (provided in the FOSS kit)
4 "Weather and Water Lab Notebooks" (provided in the FOSS kit)
For The Class:
1 VCR and Monitor
1 Video entitled "Wonders of Water"
Multimedia (computer) setup
1 FOSS CD Rom

Lesson 4: Modeling Land and Water (Designed as a Double-block, or as consecutive lessons).

This lesson is the first of a series of lessons, lasting throughout the duration of the unit, in which the students will actively construct and test a model system designed to demonstrate the water cycle. This will be inquiry based, with the students working with the teacher to come up with a driving question centered around the dynamics of the water cycle. The students now have a much deeper understanding of how the water cycle is related to weather and climate, through land, water-bodies, and the atmosphere. The standards-based curriculum that will be used for these lessons is the "Land and Water" STC guide, as described above.

This lesson will be based on "Lesson 2, The Water Cycle: Modeling Land and Water" from the STC resource. Students, working in groups of 3-4, will begin the design and construction of a representation, or model, of land, water, and atmosphere on the Earth. They will be allowed to use, based on their own inquiry, four types of soil: sand, gravel, clay and humus; or mixtures of these. They will also use their creativity in using plantings (mostly either small cuttings from house plants, or fast-growing beans) to mimic real world plants and shrubs.

The global interactions that occur between land and water are too big, too far away, and too complex for students to study firsthand. However, by using a model, they will be able to simulate some of these interactions in the classroom. Students will use their models throughout the remainder of this unit to discover and confirm some basic changes and interactions of land, water, and air. With these models, students set up an investigation of the water cycle. This experience demonstrates to students the concept that water changes its physical form and allows them to observe how water moves into the air and returns to earth as precipitation.

The lesson will begin with a discussion of modeling, and thinking about how we might make a model of the water cycle. We will understand and emphasize that models are representations of complex objects, systems, or events that scientists really do use to help in understanding larger phenomena. It is also important to understand that the water cycle is a complex, and abstract concept. Not all of the processes of the water cycle can easily be observed in this or subsequent lessons. We will see that there are some limitations to using a model.

The concept of modeling will be introduced by asking questions such as:
What models have the students seen or made, personally?
How does the size of the model compare with the size of the actual object, process or event?
How do features of the model compare with those of the actual object?
What are some examples of models that scientists might use?
Why do scientists use models?

The students, working in groups, will spend the remainder of the lesson constructing their models. The procedures for making the models are described in detail in the STC "Land and Water" teacher's resource on pages 31-39. Some of the observations students will make can be seen during the course of a class period, while many others will need an overnight or potentially over several days or over a weekend. The timing of the class activities is very important in this regard.

Several extensions are possible in conjunction with this lesson. For example: Do solids evaporate? A small pan of salt could be placed in the model, mimicking a lake. When the water evaporates, we can question why the salt is left behind. The question of the effect of temperature can be asked, and we can consider both centigrade and Fahrenheit, and introduce the mathematics of temperature conversion. A cold day can be simulated by the addition of ice packs, and a hot day could be modeled by using the light and heat of a flashlight mimicking the sun.

A possible homework assignment would be to challenge students to find evidence of the water cycle (evaporation, condensation) at home and outdoors. The students can use their creativity by writing their observations either through prose, or poetry, or haiku, thereby adding a language arts extension.

<u>Preparations needed for this lesson</u>:
1. Preview the "Student Instructions for Modeling the Water Cycle" on pages 38-39 of the STC teachers resource.
2. Consider how the students will brainstorm on the uses of models for studying the water cycle. Consider leading questions, as well as what questions the kids are likely to have.
3. Prepare those materials that need prior assembly (see pages 32-33).
4. Make sure soil samples, plant cuttings, and beans are ready.
5. Set up a materials distribution center (Described as item 10 on page 33 and Figure 2-3, on page 34).
6. Set up a clean and rinse station for student personal cleanup.
7. Line a trash can with a plastic bag for easy cleanup.
8. Get sponges and brooms ready.
9. It is very important for the teacher to set up a model in advance – to make sure it will work, and to find out where the problems are likely to be.

<u>Required materials for this lesson are</u>:
<u>For each student</u>

1 science notebook

'Stream Table Model materials for each group of four

*1 clear plastic box, 40 x 28 x 15 cm (16 x 1 1 x 6 in) with lid, drain hole, and rubber stopper

*1 box, bag, or other container to hold the following items:

*1 small absorbent pad, 58.4x61 cm (23x24 in] H large absorbent pad, 58.4x9 1.4 cm (23x36 in]

*1 plastic plaster spreader, 10 cm (4 inj wide

*1 spoon

* 1 metric ruler

*2 hand lenses

*1 catch bucket, 3. 8 liters (1 gal)

Other materials For each group of Four

1 capped, 2-liter soda bottle, containing 0.5 liter (500 ml or 1 pt) of *warm* water j

1 piece of plastic wrap, 60 x 35 cm (24 x 14 in)

1 large rubber band, 17.5 x 0,3 cm (7 x *'A* in)

1 Rubbermaid® Blue Ice® pack, 7 x 3.5 x 12 cm *(2%* x 1% x 4% in)

For the class

Daily Water Usage (blackline master, pg. 44, optional)

Brainstorming list, "What We Think About Modeling Land and Water"

Masking tape

Assorted colored markers

Humus

Gravel

Clay

Sand 1 holding box for moistening sand

Sample models (such as a globe or toy car) 1 clear plastic cup, 270 ml (9 oz)

1 graduated beaker, 1 liter (1 qt)

2 rinse buckets, 3.8 liters (1 gal), for rinsing hands and materials 1 black china marker

Bucket of ice or cooler

Cleanup supplies: lined trash can, trash bags, sponges, broom, dustpan, paper towels

* Note that the materials for the 'Stream Table Model' marked with an asterisk (*) will be used in most of the subsequent lessons.

Week Two (3-5 days of student focused activities)

Activity	Determination of acidity and pH	Modeling Acid Rain using the Land and Water	Finish measurements from their model and begin work on	Culminating Activity: The Laveview Town	

		models	the culminating activity	Meeting on the Problem of Acid Rain	
At home assignment	Written Acid/Base Questions Assignment	Make notes of examples of Runoff and erosion from the student's own environment, or from printed sources.	Students will work on their own, and with their small groups, on their roles for the culminating activity	Review for in-class assessments	
Concept	The Water Cycle can be affected by human intervention.	Scientific models can be used to test natural, real-world phenomena and systems.	Scientific investigation needs to be a collaborative effort	Scientific investigation can (and sometimes should) be done in context with the community	
Process Skill	Measuring	Predicting	Observing		

Lesson 5: Let's Learn About Acid Rain

This is the first of two lessons that I will teach in the class of Stacey Smiar at the Fayerweather School in Cambridge, MA. I was introduced to her via email through a mutual acquaintance. Stacey is a highly respected middle school science teacher who has received awards and grants as a result of excellence in teaching. It is truly a pleasure working with her.

The GEMS "Acid Rain" curriculum resource is used for this lesson. The activity is covered in "session 2: Introduction to Acidity and pH", pages 20-39.

In this lesson we will start from the student's everyday knowledge and experience to learn about acids and bases. Students will notice that they use, and drink, a wide variety of liquids that have the chemical classification of acids and bases. Students will be provided with a simple introduction to the science necessary to understand what is meant by "acid" rain.

Relationship of this Lesson to the unit:

Now that the students have a good understanding of the water cycle, they are ready to learn how to apply their new knowledge to issues that are important in their own lives. In other words, how do the scientific ideas such as evaporation, condensation, groundwater, and precipitation have a relationship to their daily existence? For example, they are all aware of the idea of Global Warming, and the possible global impact that humans can have on the planet. For this particular unit, the phenomenon of Acid Rain will fit in better due to the direct relationship to the water cycle, and the subsequent lessons looking at rain, runoff and weather. We will also reinforce another scientific concept that the students have seen before, acidity and pH. By extension, we will link the pH scale to a mathematics principle they recently learned, decimals, and powers of ten. Linking "exponents and powers of ten" is consistent with the Massachusetts "*Mathematics Curriculum Frameworks"* for the 5th and 6th grades, as described by:

6.N.1 Demonstrate an understanding of positive integer exponents, in particular, when used in powers of ten, e.g., 10^2, 10^5.

Concept:

- The one new concept that will be introduced is that the water cycle can be affected by human intervention. Students will explore this type of change though a study of human-induced acid rain. Some of the causes, will be discussed in the context of the water cycle, and effects on the living environment, and limestone statues will be discussed. We will take a look at a simple way to neutralize an acid, by seeing if we can bring an acid pH close to neutral by adding another type of chemical known as a base. Students will learn (and for about half of the class, review) a new way to measure whether a substance is an acid, with the use of pH paper.

Process Skill:

- The major process skill for this lesson is making accurate measurements. A secondary process skill will be the interpretation of the data to infer broader environmental effects.

Science Habit of Mind:

- This activity will focus on engaging the students to be curious, careful and accurate in making observations and keeping good records of investigations and observations, being mindful to not change the records later.

Other Subject Area Objectives:

- Mathematics: Decimals, Fractions and introduction to power of ten.
- Life Science
- Social Studies: The effects of acid rain and pollution on people.

Session Length:

This is a 50 minute lesson, for one class period.

Preparations needed for this lesson:

1. Have handout packets Xeroxed, stapled, and ready to hand out.
2. Make and hang pH scale posters (2 – 1 for lecture room, 1 for lab room)
3. Make and hang "Sample pH chart" (2 – 1 for each section)
4. Have the 9 solution bottles ready, and centrally located.
5. Be ready with extra solutions, if necessary.
6. Have enough (at least 23) copies of "Substance Chart" ready for lab.

Lab Materials required for each group of 2-3 students:

* 12 test tubes and 1 test tube racks.
* 2 packets of Litmus pH paper
* Goggles for each student, and teachers.

Lab Materials for the class:

* Samples to be tested, placed in centralize location.

Distilled Water
Vinegar
0.1 X Vinegar
0.001 X Vinegar
Sprite Soda
Concentrated Lemon Juice
Baking Soda solution (50% w/v)
Rain water (previously collected)
Snow (new fallen, previously collected)

A few Graduated cylinders, 10ml, 50ml.
A few Beakers (100ml)
9 Eye Droppers (1 placed each solution)
2-3 extra Eye Droppers (in case of eye dropper cross contamination)

TIME	PROCEDURE	CONCEPT
5 minutes	**Student arrival and settling in.** Note: Use checkboxes on white board. I will do this so that I can use it as a reminder of where I want to go, and to keep me on topic. * Acid Rain * pH * Lab * Some Lab Challenges * Video (time permitting)	
20 minutes	**Discussion.** Distribute Handout, and begin discussion. Introduction to the topic (Acid Rain) We will build on their prior work on the Water Cycle. Main Points: * What does the class already know about Acid Rain? * How is Acid Rain different from "Normal" Rain? * Bring in relevance to their own experience, such as do they drink tap water at home, or use filtered water. * Do their parents buy bottled water? * What kinds of things eat away, or corrode other things? How about eating away at ancient statues? * Are they aware of Global Warming?	

	* Do they think there is a connection of Acid Rain and Global Warming? * Is there such a thing as “Acid Snow”? **Here are the Questions that I will keep in mind to focus and direct the class.** What is acid rain? If I see only blank expressions, I will ask leading questions such as: Do you have any observations of water pollution, or air pollution? How about your tap water at home? Has it ever come out brown or gunky? Do we think there might be some connection between rain water and our drinking water? How about corrosion of ancient statues, such as the one shown in the handout? This now brings us to a recap of the Water Cycle. How is rain formed? Where does rainwater go? Where might pollutants be introduced in the water cycle? How does messing up one part of the water cycle relate to other parts of the cycle? What chemicals do you know of that might cause pollution, and where would they come from? Is the water in rain turned into an acid, or are do chemicals mix with the water to make acid rain? What might be some effects of polluted rainwater? What might be the effects to the environment? To animals? To fish? To plants? To trees?To people? To buildings? Why do you think so? How could you tell if there is an effect caused by acid rain? What is an acid? Do you know of any acids? Is anything you eat or drink an acid? What ingredient in toothpaste might neutralize acid buildup on your teeth? What does it mean to neutralize an acid? What neutralizes an acid? D What is the relationship of pH to an acid? What is a pH scale? What does a pH scale look like? How do you measure pH? What are some things that have a high or low pH? What do you think happens if you add something with a low pH to something with a high pH? Talk about the Water Cycle. * Class has already studied the water cycle. We will review. * Diagrammed on Handout I will pass out to the class. What are some causes of Acid Rain? Relationship to Global Warming! Pollution? Contamination of air and water? What bad effects might we notice? Possible solutions.	

	* These topics have been introduced by the classroom teacher. The activity is designed to fit into the teaching curriculum. What is an acid? • This question is designed to determine the understanding of the students. The 6th graders have already studied pH, and tested solutions with red cabbage extract. Appropriate instruction will be determined based on student understanding. Who has heard of pH? Simple description. • We already know that the 6th graders know what pH is, at least on an basic level. We will expand on this so that some analyses can be done on laboratory observations. In the lab 5th and 6th graders standardly work together, so the 6th graders will be able to help the 5th graders. <u>Introduce what will be done in the lab.</u> We will test several liquids for their acid content, using Litmus pH paper. We also have recently collected samples of rain and snow. We will find out where they are on the pH scale. There are some challenges for groups who finish early. Can we take a liquid that is an acid, and make it a neutral on the pH scale? Also, there is a list of more challenging questions. `	
20 minutes	**The Lab:** This is an inquiry-based lab in which students use pH paper to determine acid levels of standard solutions. They then postulate and examine whether rain, snow and ice, previously collected from outdoors, are also acid. (Necessary materials already at central location.) "Getter" student from each group will be designated to bring (and return) samples back to their group for pH testing. <u>Standard Solutions:</u> Distilled Water Vinegar 0.1 X Vinegar 0.001 X Vinegar Sprite Soda Concentrated Lemon Juice Baking Soda solution (50% w/v) Rain water (previously collected) Snow (new fallen, previously collected)	

If student finishes pH measure-ments early	pH measurements of snow/ice and rain using Litmus pH paper. Compare results. Make sure students know how to use pH paper. Students work in groups of 2 or 3. Each student records their own data. Walking from group to group I will question the groups to make sure they understand the concept of acidity and pH. And I can begin begin assessing the progress of the class, and those places where students are likely to get stuck. **Lab Cleanup.** **Class discussion.** Is the rain acid? How about snow? As long as the pH of the rain and snow vary by greater than 0.5 pH units, the pH paper will be sensitive enough to note a variation from pH 7. Anything else interesting? For example, does the 10-fold and 100-fold dilutions of vinegar show a pattern on the pH scale? We might expect to see each differ by exactly one pH unit. **CHALLENGES**: Challenge 1: Neutralize concentrated vinegar using baking soda or detergent. Students record their data. pH is on a powers of ten scale. We know that the 6th graders have a cursory understanding of powers of 10. We will simply confirm this, and introduce this to the 5th graders. The GEMS Acid Rain teachers resource guide on page 32 of their curriculum provides an extremely good way to introduce the concept of a simplified logarithmic scale. Further exploration to engage more advanced seekers is provided on pages 124-131 of this GEMS guide. Challenge 2. Answer questions on pH problem sheet. Students can work in groups, or alone.	
10 minutes	**Video: Powers of 10** Time permitting. (If not, show at the beginning of next lesson in April).	

Lesson Assessment Rubric:

	Novice	Competent	Expert

Process Skill	Can measure with reasonable accuracy.	Understands the need for accurate measurement, and is able to follow directions in making measurements.	Consistently makes accurate measurements, and will often check results of own volition.
Habit of Mind	Needs to be reminded to write in the science notebook.	Typically records results of observations.	Keeps accurate records of investigations and observations.
Concept	Can recognize color change on Litmus Paper and write the comparative number in a notebook.	Understands that pH represents acid level of a liquid, and that there is a scale of acid levels.	Understands that the pH scale is on a logarithmic (or powers of 10) scale, and that acidity represents a specific characteristic of a substance.

First, the comments by the classroom teacher:

Strengths:
Well planned, organized lesson in terms of engaging the students the students with an age appropriate topic (pH), connecting what could be an abstract concept to real life (acid rain and its effects), as well as impressing upon them the impact industry has on their environment.

Hands-on experiment that students love- not overwhelming in terms of procedures or depth of content in a 45-minute period. Realistic. This was terrific, and I hope you could tell that the kids loved it.

Since it was a unique combined grade level group of 5th and 6th graders, and the 6th graders had already studied pH, you appropriately planned ways to challenge them. (Different vinegar solutions, limestone/egg shells, neutralizing two solutions, and powers of ten. Even though we didn't get to all these, I think we could both tell that the 6th graders felt appropriately challenged with the three different vinegar solutions and egg shells.)

Your strong listening skills and intuition (although I don't like using that word to refer to teachers, since much of what we do actually is learned, planned, acquired experience) helped you fill in the blanks when students in the first class weren't offering much in the discussion, and students in the second group were more

knowledgeable and ready and raring to go. You listened and responded on the fly to where kids were right then and there. This is a critical skill for teachers.

Room for improvement:
Just a couple logistical things:

Use the board to help visual learners. As you did midway through the second introduction, draw a 0-14 scale on the white board. (You had done this in advance, but had it in the lab area for a wrap up discussion.) When discussing acidity, it is not intuitive for kids to say the "lower the pH, the more acidic it is." Seeing the scale would help.

Clarity in directions about the fact that what the solutions they were testing were not necessarily on the "substance chart" you had given them.
As you found out, this confused some.

As you pointed out, the decision of when to pass out handouts is tricky, since kids look through them as soon as you pass them out. Ideally, as you had requested, it would be great to have pictures on a LCD projector for you to click through. But, the reality of working in a school is what we faced
yesterday: sharing a classroom with someone, minimal prep time, and minimal set up time between classes. So, I think you were wise to use the 15 minutes you had to set up the lab rather than hook up a computer and projector.

My Reflection:

I pretty much agree with Stacey's evaluation. In addition, as we discussed in class, I spent more time than necessary in my pre-lab lecture, which ended up cutting short all that I wanted to accomplish in the lab. So, as we will see in my next reflection, I needed to finish up the interesting connection of the pH scale being represented as a "power of 10" scale at the beginning of the next lap period. I also should have drawn up a more representative "substance chart" rather than simply relying on the one in the GEMS resource. And I think overall, working on how much time I need to spend on the flow of class activities and discussions will be important for me. But as a first teaching experience I am pleased, and I see ways in which I need to improve.

Lesson 6: Modeling "Normal" Rain and Acid Rain on Land (with runoff), and Introduction of the "Culminating Activity"

The students will begin this lesson by wrapping up their initial observations of their "Land and Water" Stream Table Model experiments and relating their observations to the various parts of the water cycle. They will note their observations in their science notebooks. Following this, they are now ready to investigate more closely the effects of rain on their models. This lesson is described as "Lesson 3, Modeling Rain on Land" in the STC Teachers Resource, pages 47-54. Some groups will be assigned to simulate acid rain" by using "rain water" in the form of low pH dilute vinegar solutions. This modification is described in the GEMS Acid Rain module on pages 54-71, in the chapter titled "Fake Lakes".

Students will use one liter of water dispensed by a sprinkling bottle to simulate rain. By gently shaking an inverted 2-liter soda bottle (fitted with a sprinkler head) up and down, a gentle rain will result. If they shake the bottle more vigorously, a more forceful rain will dislodge soil particles and carry them across the land and eventually be "runoff" which can then be collected into a catch bucket below the "stream table model". Although the students will "rain" on their soil for only a few minutes, the results will model the effects of rainwater on land over longer periods of time on earth. Modeling is an important concept that will be reviewed in this lesson.

In conducting this investigation with their models, the students will work in their cooperative groups, like scientists. They will discuss within their groups, their observations of their specific type of rain, the effects of rain, of different pH, on the land soil and water (lake).

Primarily we will be interested in observing differences, over time, of the effect of acidified rain on their models. Once the rain falls on their models, the students will have the opportunity over the next two to three lessons observe the effects of pH on their models. Each group will be asked to write their predictions of what they think is likely to result from differences in rain pH.

Through this lesson, students will reinforce their understanding of the concept of pH and acidity. They will be able to test their predictions of what effects acid rain will have on soil, lake water, and possibly in atmospheric moisture by taking the pH of the condensation formed at the "ceiling" of their model. The students may notice that over the next two lessons, some of their plantings begin to wilt or die. Some of the more advanced students may observe that different types of soil become more, or less, acidic even if the pH of the rain remains constant. Students will be able to show that there is an interaction between soil and lake water. And, by recalling the "neutralization challenge" from the previous lesson, many of the students may suggest, or even try to demonstrate, that the acidic lake water may be able to be brought closer to a neutral pH.

The students will be asked to clean up twenty minutes earlier this period, since they will be able to continue with their observations in the next session. The last fifteen minutes of the lesson will be dedicated the distribution of a handout and a brief introduction to what will be the culminating activity for this unit, the Town of Lakeview "Town Meeting on Acid Rain". The class will be informed that in the session after next, they are going to represent the viewpoints of different interest groups in an Emergency Town Meeting called to discuss the acid rain problem affecting an imaginary town named Lakeview. They will be divided (they will be given the opportunity to volunteer) into four groups which will be representative of local citizens. The groups are: Manufacturers, Fishing Workers, Politicians, and Local Residents.

Their homework will be to read the information and articles in the handouts, and think about what the roles and opinions of their group will be. They should also begin working with their group before the next class. Their understanding of the concepts covered in the unit (the water cycle, and the effects of perturbing the water cycle in one or more ways) will be partially assessed through their participation and insights at their mock town meeting. The students will have most of the next session to work with their group. And the only homework assignment will be to prepare their town meeting presentation. The Town Meeting lesson plans are covered in the GEMS Acid Rain module on pages 79-86, 95-97, and 104-113.

<u>Preparations needed for this lesson</u>:

1. Prepare sprinkler heads and soda bottle systems.
    - A. Fill bottles with 500 ml water (or diluted vinegar preparation).
    - B. Attach sprinkler heads to bottlse with electrical tape.

2. Set up distribution center for bottle systems.
3. Preview the lesson. Decide how students will use the rain systems to model rain.
4. Prepare handouts (information and articles for introduction to the Town Meeting plan.
5. Prepare how students will be selected to represent the four citizens groups.
6. Prepare how students will be assessed by their participation in the town meeting.

Required materials for this lesson are:

For each student:
1 science notebook
1 set of Town Meeting handouts

For each group:

'Stream Table Model materials
1 clear plastic box, 40 x 28 x 15 cm (16 x 1 1 x 6 in) with lid, drain hole, and rubber stopper
1 box, bag, or other container to hold the following items:
1 small absorbent pad, 58.4x61 cm (23x24 in] H large absorbent pad, 58.4x9 1.4 cm (23x36 in]
1 plastic plaster spreader, 10 cm (4 inj wide
1 spoon
1 metric ruler
2 hand lenses
1 catch bucket, 3. 8 liters (1 gal)

1 sprinkler head
1 2-liter soda bottle filled with 500 ml of one of the following:
Water
Undiluted vinegar
0.1 X Vinegar
0.01 X Vinegar

For the class:
1 graduated beaker (1 liter)
2 rolls of electrical tape
Cleanup supplies: lined trash can, trash bags, sponges, broom, dustpan, paper towels

Lesson 6A: Modeling "Normal" Rain and Acid Rain on Land (with runoff)

This is the second of two lessons that I will teach in the class of Stacey Smiar at the Fayerweather School in Cambridge, MA. I plan to teach this lesson to the same 5th/6th grade classes on Tuesday April 24th. This particular lesson is a modification of Lesson 6, above. The need to modify the set up of the Lesson from the STC Teacher's Resource is due to the obvious fact that it is a stand-alone lesson, designed to flow from Lesson 5, above. The fundamental set up, and scientific experiment is the same as Lesson 6. The procedure for this lesson is from the GEMS Acid Rain teacher's guide.

The GEMS "Acid Rain" curriculum resource is used for this lesson. The activity is covered in "session 4: Fake Lakes", pages 54-71.

Like lesson 6 above, students will reinforce their understanding of the concept of pH and acidity. With the use of a simple model, they will be able to test the effects that "normal" and "acid" rain will have on different types of soil, and "groundwater runoff" into a lake.

Relationship of this Lesson to Lesson 5:

We will continue our exploration of the relationship of pH to acid rain, and how this concept fits in with the Earth's water cycle. Now that the students understand how pH is related to acid rain, we can now apply this to a lab experiment in which we model a real-world phenomenon. Students will use their understanding of testing whether a liquid is an acid to testing a model of rain of different pH's effect on groundwater runoff from different types of soil into a simulated lake.

Concept:

The new concept that will be introduced today is that scientific models can be used to test natural, real-world phenomena and systems.

Process Skill:

Students will, within a small collaborative group, construct simple models (of different soil types near a "fake lake") to test the effect of changing one variable (the different pH's of "rain" on the soil) on the acid content of the soil and lake.

Science Habit of Mind:

It is especially important in this lab to make sure only on variable is changed at a time. It's possible that some groups may try to change both the type of soil used (or use different types of mixtures) as they try different pH's of the rain water. Therefore one habit of mind will be to recognize when comparisons might not be fair because some conditions are not kept the same.

Other Subject Area Objectives:

- Mathematics: Decimals, and powers of ten.
- Mathematics: Using models to think about larger phenomena.
- Social Studies: The effects of acid rain and pollution on people.

Session Length:

This is a 50 minute lesson, for one class period.

<u>Preparations needed for this lesson</u>:

Set up for showing video, "Powers of Ten".
Photocopy Figure 6.1 from the STC Land and Water Teacher's Resource (page 82).
Figure out how I want to draw the coffee filter – cups diagram.

<u>Lab Materials required for each group of 2-3 students:</u>

Disposable Gloves for handling soil (2 or 3 pairs for each student)

Goggles for each student

Lab Materials for the class:

4 types of soil (small bags)
4 Scoops for scooping soil
A small commercial bag of Mr. Coffee coffee filters
A small bag (of 48) plastic drinking cups (smaller mouth)
Another small bag (of 48) plastic drinking cups (larger mouth)
Litmus pH paper (2 or 3 boxes)
3 eyedroppers for dispensing liquids
Distilled Water (about 200 ml)
0.1 X Vinegar (about 200 ml)
0.01 X Vinegar (about 200 ml)
A bag of 50 rubber bands

TIME	PROCEDURE	CONCEPT
2 Minutes	**Student arrival and settling in.** Note: Use checkboxes on white board. I will do this so that I can use it as a reminder of where I want to go, and to keep me on topic. It also lets the students know what is coming up. • Review pH lab • Soil/Lake model • Video • Lab experiment • Review	
8 Minutes	This lesson is a modified version of the "Fake Lakes" lesson in the GEMS Acid Rain Teacher's Resource (pages 54-71). **This class session begins in the Lab.** **Class Introduction and Conversation/Dialogue:** Introduction of concept: Modeling of groundwater runoff under varying conditions of acid "rain". This lesson looks in some detail at the part of the water cycle in which water moves from the soil to a "lake". We will look at "rain water" that would likely fall at different locations. Our conversation will begin where the last one ended (from Lesson 5). **Questions I will ask, along with the discussion:** What types of locations are we likely to see acid rain compared to "normal" rain? Cities, Countryside, Less populated areas (Africa, South American Jungles). Remind the students of the Black Forrest in Germany and Ancient Statues (from last time). Do you think we can relate types of rainfall to what happens in the soil and lakes and streams? From last time they should be able to understand the effects.	

	Direct the students to a photocopy I've made of Figure 6.1 from the STC Land and Water Teacher's Resource (page 82). How can we test whether acid rain and acid soil can make lakes, rivers and streams more acid? We can go on a field trip and look at soil and lake/stream/river water and test the pH. Or, can we construct a model to test it? I will then draw a diagram of the coffee filter – cups model (a similar (but, much simpler) idea to the "bottle biology" model we made in Prof. Jablon's class on Sunday March 25, 2007). An "upper" portion will hold the soil, while a "lower" portion will be the lake. The model will be initially designed as two un connected parts (as a time expedient). Students will choose their soil type and rain on it with the available normal or acid rains. The lake will contain about 20 ml of distilled water. The components will be combined by flipping over the soil to filter through the coffee filter over the lake cup and the groundwater will runoff through the coffee filter into the lake. The mouth of the lake cup will be larger than the mouth of the soil cup so that the inverted soil cup can easily fit into the lake cup.	
10 Minutes	**Lab, Part I:** Ask the students how we might control variables in this model? Since there are only two variables (the pH of the rain, and the type of soil we will use), this should be straight forward. If they have no clue, though, I will ask them what could change in their models. Why is it important to keep all things constant, while testing only one variable at a time? What materials are we using? What are we testing? For the sake of being efficient within a 50 minute block of time, I will ultimately tell them that within their group they will use one type of soil, and test the three types of rain on that soil type. To make efficient use of time, the necessary cups, rubber bands and coffee filters for that group will already be at the lab tables. Assign a "getter" to get a soil type or mixture for that group. Once the soil is in place, and each group has its materials "the getter" will get their three rain samples, and students will pour 20 ml of rain on their soil. They will cover their soil cup with a coffee filter held in place with a rubber band.	

10 Minutes	Since groundwater runoff does not happen immediately when it rains, we will take a break to remind ourselves that the pH acidity scale in on a power of ten scale. We will watch a brief fun video that shows what is meant by powers of ten. **Video: "Powers of Ten"** (an 8 minute video)	
5 minutes 5 Minutes	**Lab, Part II:** We can now test the effect of different rain on the pH of the Lakes. Students combine the two components of the model, and allow the rainwater to filter into the lake. (Bur first, I will ask them if the need to test the pH of anything BEFORE they dump the rain into the lakes). Students will record the pH of their model components on a sheet I will prepare for them. And we will discuss their findings. **Lab Cleanup.**	

Lesson Assessment Rubric:

	Novice	Competent	Expert
Process Skill	Has trouble following the plan to construct and test the model.	Construsts a good model.	Constructs the model accurately, and competently performs the testing
Habit of Mind	Has more than one changing variable, and does not know exactly how to do the testing.	Knows to keep one variable constant, but does not completely test	Understands the need to keep all but one variable constant, while figuring what tests to make on the one variable.
Concept	Does not readily see the connection betwwen the model and the outside world.	Is generally able to follow reasoning for modeling.	Understands the concept of modeling with realization of real-world implications of size and scope.

My Reflection:

This class also went very well. The kids remembered me from last month, and we maintained the good connection we had already established. Also, after the class, the classroom instructor asked me if I would like to come back later in the year as a substitute for either her class, or for a math class. An interesting coincidence is that earlier in the morning the students did some work with factors of 10 in their math class, so introducing the pH as a scale of powers of 10 fit in nicely.

With that said, however, there are a few things that I feel could be improved upon. This class was intended to be a follow up to the one that I did about a month ago. One month is a long time for some of the kids to immediately recall the details of what was covered, so I needed to review for a few minutes to allow the entire class to be able to move forward. This put a time crunch on what I wanted to cover, so I would have liked to extend this lesson into the first few minutes of the next class.

Also, some of the kids had difficulty making the connection of the water cycle to the model I had them create. I realized that it would have been a good idea for me to explain in a more diagrammatic fashion how the model should be constructed.

Lesson 7: Final Observations of the Water Cycle Model, and Continue Work on "Culminating Activity"

Students will be given the first fifteen minutes of the class to record their final observations of their Land and Water Model. By now the kids should be very comfortable working with their model systems, so they will be able to get their models, set up, and begin work without prompting. They will be given 5 minutes to clean up.

And, although I am formally announcing this as the last time they can make observations, I am willing to accept valid reasoning to continue their observations before the next class if they are able to make a cogent argument for their position at the town meeting.

For assessment, I will expect each student write up a formal report describing their procedures and observations of their Model. I will also expect a cogent analysis of the project as a model for a real-world system. This assignment will be due at the beginning of the class period following "Lesson 8".

The remainder of this class period (thirty five minutes) will be spent working in their "Lakeview citizens" groups and preparing for the Town Meeting. We will begin with a discussion of the homework assignment, focusing on possible solutions posed to the problems posed by acid rain. The discussion will help orient the students towards considering additional solutions during their town meeting preparation in the latter part of the session.

Now that they are familiar with their group and roles, we will assign specific responsibilities to each student.

Reader: Each group will have a reader, who will read the instructions and description of their group.

Writer: Will note down what the group discusses, and what it wants to say at the town meeting. This student will take notes in outline form to hand in to the teacher for review.

Presenter(s): On behalf of the group, will present their case to the town meeting.

Clarifier: Will listen carefully to the ideas suggested, and try to put them into words that can be easily understood and written down.

The teacher will remind the groups that they have three main tasks in preparing for the town meeting:

1. A description of the group's main points of view about the town's problems with acid rain.
2. A list of questions or comments they want to pose to other groups at the town meeting.
3. Some ideas about possible solutions to the acid rain problem that are acceptable to more than one interest group.

The teacher will circulate through the class to make sure the groups have appointed people to the various tasks and are progressing on task. The teacher will also need to answer specific questions that students ask about conditions, resources, etc. in the town. The teacher needs to be prepared with consistent and creative responses to these questions, keeping to the central issues. Students will also likely have creative ideas about the town of Lakeview.

The GEMS resource provides a reasonable starting point for Lakeview on pages 83-86. Also, if a group is short on ideas the teacher will direct them to the description of their group, and if

necessary, offer suggestions. The teacher will also encourage the groups to be creative in enhancing the specifics of their group, for example by naming the fishing club, or detailing what companies manufacture, etc.

Five to ten minutes before the end of the session the teacher will remind the class that they should have a clear written statement about who their group is, how they view the problem of acid rain in relation to the town, and what solutions they would propose.

Since the teacher will be the Lakeview Mayor moderating the Town Meeting during the next lesson, it will be important to carefully check the group's preparation notes, not only for coherence, but also to consider possible solutions that are broadly acceptable.

Before the class ends it is important to mention to the groups that there will be five minutes at the beginning of the next lesson to go over what they've written to review and make changes. The homework assignment is to continue working with their groups, if possible, to prepare for the Town Meeting.

Preparations needed for this lesson:

1. Make sure Land and Water Models are still in reasonably good condition
2. Check over the homework assignments from last class to assess where the students are in their understanding of the water cycle and acid rain. Also to make sure they are off on the right foot for the town meeting.
3. Plan and prepare for group's questions regarding the imaginary town, and different group's assignments.
4. Plan student responsibilities within each group.

Required materials for this lesson are:

For each student:
1 science notebook

For each group:

'Stream Table Model materials
1 clear plastic box, 40 x 28 x 15 cm (16 x 1 1 x 6 in) with lid, drain hole, and rubber stopper
1 box, bag, or other container to hold the following items:
1 small absorbent pad, 58.4x61 cm (23x24 in] H large absorbent pad, 58.4x9 1.4 cm (23x36 in]
1 plastic plaster spreader, 10 cm (4 inj wide
1 spoon
1 metric ruler
2 hand lenses
1 catch bucket, 3. 8 liters (1 gal)

For the class:
Cleanup supplies: lined trash can, trash bags, sponges, broom, dustpan, paper towels
Extra Town Meeting handouts, for students who were absent last lesson

Lesson 8: "Culminating Activity": *Town Meeting: Topic "Acid Rain and Our Community*

In this lesson, the teacher, in the role of town Mayor, calls the class to order for an Emergency Town Meeting on the Impending Problem of Acid Rain. The emphasis is on structured discussion aimed at refining and reflecting upon suggestions for resolving the local problems caused by acid rain. The lesson has interdisciplinary extensions in social studies, language arts, and possibly mathematics.

At the end of the lesson, students should have a clearer sense of how they personally feel and think about the problem of acid rain. They should also have enough confidence in their own knowledge to follow the issue further.

The purposes of the lesson are to:

1. Ask students to recall what they have learned about acid rain in the context of the broader water cycle.
2. Have students synthesize their knowledge to produce a coherent presentation from a particular point of view.
3. Give students experience suggesting, modifying, and presenting solutions in a revised form to seek wider agreement.

The class will have a clear structure, with defined time limits and a definite conclusion. Each of the groups will have the opportunity to suggest a range of possible solutions that might be acceptable to the other groups.

The lesson will begin with the groups meeting separately for the first five minutes. By this time they should already have their opinions and supporting facts in place. This amount of time will allow them to finalize their presentation.

The "Student Presentation and Responses" part of the lesson will last 25 minutes. The Lakeview town Mayor (the teacher) will call the Town Meeting to order. The GEMS guide suggests that each group has a brief description of who they are and what they do, as well as a statement of what they think about the acid rain issue. They should also have in min at least one possible solution from their point of view. And they should have two statements or questions prepared to direct to other groups. The Teacher-Mayor runs the town meeting, is the timekeeper, and clarifies the points and questions, if necessary.

The final 15-20 minutes of the lesson is when the students and teacher have the opportunity to brainstorm possible solutions to the issue of acid rain that are likely to be acceptable to as much of the towns people as possible.

The GEMS guide suggests having the students return to their groups at this point and write up their solutions on strips of paper, as bullet points. The teacher circulates among the groups to help clarify issues and solutions, and to carry ideas between groups. I would modify this to have a student representative communicate new ideas to the other groups. And at the last few minutes of the lesson, the students post their paper strips at designated places on the wall. An alternative would be to have students write their ideas on flip chart paper.

The mini-unit culminates with the students actively participating in a collaborative way bring together what they have learned about the role and dynamics of the Earth as a water planet, and how the issue of acid rain integrates at various levels into the water cycle.

If I Had Time: "Assignment for Chapter 5".

Read the section on using computer probes (MBLs) as part of science instruction. Are there any probes that you could use in your unit plan.

The "Model-It Visual and Simulation Software Tool" appears very suitable for this unit. Considering the "Land and Water" Model that is used in the unit, this software package could be used by the students to more effectively make predictions about effects on the water cycle under varying conditions. The software could also be effective in making predictions useful for the Town Meeting. Using the Model-It software they could create models that represent their hypothesis, and test it for feasibility.

PASCO's website:

Additionally, from the PASCO website, the Hydromania Teacher Resource Kit is useful for the study of Acid Rain, which is a cornerstone of the unit.

Here are additional web-sites that could be included in the unit plan:

The School Power...NaturallySM innovative program from the New York State Energy Research and Development Authority (NYSERDA) module on "What is pH and why is it important? SPN LESSON #19" is a very interesting and potentially useful website for extension of the "Acid Rain" lesson. The activity plan is similar to what I have in Lesson #5, but goes deeper in its connection to the environmental consequences of Acid Rain. It is also adapted for grades 5 and 6. The URL is http://www.powernaturally.org/Programs/SchoolPowerNaturally/InTheClassroom/level2.asp?i=9#Lesson20.

There is also a good simulation of the water cycle at the website of edumedia http://www.edumedia-sciences.com/a88_l2-water-cycle.html.

Two types of assessment that I would not have thought to use for my unit plan, but that I believe are very appropriate to assess the objectives of my unit plan:

The two means of assessment that are appropriate, and that I had not thought of are:

1. A Daily Journal
2. Drawing.

1. A daily journal is particularly useful as an informal means of allowing a student to describe as a narrative their thoughts and feelings regarding their projects in the unit. The Water Cycle has many facets, and can be affected at various input points. Much of the objective observations can be captured in a lab notebook, but there are also a subjective aspects, such as the feelings one might have regarding rain and snow, and the negative impacts on the pristine environment by acid rain, global warming, and other results of industrialization. A student may very well have strong feelings about nature, yet be unable to express themselves through the relative coldness of a science notebook. Poetry, haiku, artwork, music (a student may compose a song in their journal) are all ways that scientific concepts can be expressed.

2. The Land and Water Model that the students use for about half of the unit is, of course, a scientific estimation (or depiction) of what happens in the real-world. Artistic students who grasp the concept may not be so interested in jotting down numbers and bullet points in a notebook. However, give them some colored pencils, crayons, or markers, you may very well see some very realistic renderings. Modeling, in general, is very amenable to full-color drawings. Acid rain might be shown as black or brown, rather than a pristine shiny silver of normal rain. Likewise, clouds, lakes, streams, as well as industrial pollutants could come to life as drawn by an otherwise non-left-brain student. The corrosive effects of acid rain on ancient statues may also be shown very vividly.