It's More Than *Just* Water: Science Instruction Built on Inquiry-based Principles

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INTRODUCTION

"Ms. David, what are you talking about?" Thus spoke Luke, one of my third graders, while I was excitedly trying to explain the cell and its composition, using a diagram and an egg. That's when it hit me. Indeed, what was I talking about? Or, rather, what was I trying to do? You can't teach science through diagrams and analogies. That's how it all began.

One of the most difficult questions I've ever come across in questionnaires – possibly most useless, too – is "What is your favorite book?" I could pick dozens every time. However, there are times when certain books influence me more than others. One of these is *Teaching with the Brain in Mind* by Eric Jensen. This particular book put learning and forming long-term memories into a new perspective for me. It made me better understand how fundamentally different memories that are formed through academic learning are from memories formed through experience. This includes how they are stored in different areas of the brain, how they are retrieved in different ways, and why the latter outlast the former. What we learn from experience stays with us longer and better than what we learn as part of our academic instruction. It also helps us construct meaning of the real world rather than store knowledge received through studying books and attending lectures.

I want the learning in my classroom to be more like the learning and memories we create through experience. I strive for discovery learning and for teaching as close to real life as possible. That is why my goal is to bring experimentation in our learning as a way of recreating the world in my classroom.

As a third grade teacher in a self-contained classroom, I too often see science neglected or assigned the status of a "second-class subject." When it is taught, science tends to be taught prescriptively rather than investigated, discovered, and/or proved, and the science textbook becomes the core curriculum rather than just a starting point or a mere resource. I am planning this curriculum unit in an attempt to change this marginal role that science has come to occupy in our elementary classrooms.

Most of today's education in our school district unfortunately focuses on the standardized tests, such as the TAKS and Stanford 10 tests. Despite the principles we affirm we believe in district-wide, we still seem to spend an awful lot of time preparing the students for the tests, and the teaching in our classrooms seems to resemble teaching to the test, more and more so as the testing time approaches. I am part of a data-driven

school that focuses heavily on TAKS scores and more often than not on TAKS-oriented instruction. The standardized tests don't seem to mean an end-of-year assessment any more; they are an objective and end in themselves.

The risks I am most concerned about in the context of the heavy focus of TAKS preparation in my school is the detrimental effect this teaching to the test has on the students' ability to think. Most decisions my students make in school and later on in life are not multiple choice. The way they solve problems now as well as later on is rarely about making a selection from a given set of options. I certainly understand that standardized tests are needed for accountability reasons, teachers' and students' alike. However, I refuse to see the role of TAKS as the entirety of core curriculum, teaching strategy, and assessment method. It is in the light of such concerns that I have planned my unit, as well as in an effort to prove that an approach that ensures both teaching such skills as critical thinking, logic, etc. and success on the TAKS are possible.

Another issue my unit stems from is the statute of science as a true challenge in my classroom. My students and I have spent a great deal of our time this year trying to make up for the time lost in the previous school years. Although third graders, the reading ability of the majority of my students was somewhere between first and second grade. This posed a double problem, not only in terms of the additional time spent in accelerated reading instruction, but also in the frustration often felt by the students (despite their great curiosity) whenever they tried to find information in the science textbook, the internet, or other science resources. We gradually overcame these problems by managing the little time we had in a more proficient manner (which sometimes meant "sneaking' class science projects in ancillary or dismissal time, or carrying on conversations over lunch trays on what we had observed in our experiments). I also made good use of all available audio and video resources, which benefited all of my students (both LEP – Limited English Proficiency - and regular instruction). It was in such conditions that I suddenly became aware of the benefits that interdisciplinary units, built on inquiry-based principles, would bring to my classroom.

My unit, though with a focus on science, is interdisciplinary in means and purpose. Over the course of a few weeks, my students and I will investigate water, its uses, its cycle in nature, and pollution. However, the context will not always be the one of scientific investigation and/or discussion. We will read a variety of texts, which will give the students an opportunity to become more familiar with the characteristics of non-fiction and expository texts, as well as such distinctions as fact - opinion, fiction – nonfiction, cause – effect, and such skills as compare and contrast, summarize, identify important details and main ideas. My students will also be involved in writing activities: this unit will give us a chance to focus on descriptive writing, as well as persuasive (when working on an awareness-raising campaign on pollution). Math skills, such as measurement, addition, subtraction, problem-solving, averaging, and representing data in bar graphs will be reviewed or taught during this unit. Students will also work in learning

centers on projects involving social studies: we will discuss oceans, lakes, and rivers, as well as environmental concerns.

UNIT BACKGROUND

The theme of my unit is the environment and our interactions with it, with a focus on water. As science is an integral part of everyday life, students need to be aware of their interactions with the world and the potential impact of human life on the world around them. My unit will focus on the water cycle in nature, water as a resource, and water pollution. Water is, after all, what my students encounter every day, drink, use in more than one way, as well as mostly consist of!

Water pollutants can be categorized into microorganisms (such as bacteria and viruses), suspended solids (such as feces, dirt, and leaves), inorganic compounds (minerals such as salt, iron, lead, mercury, etc.), synthetic organic compounds (such as trihalomethanes, pesticides, and gasoline), and radioactive materials (Lucas 58). Though to different degrees, all these pollutants are harmful to humans and/or the environment.

The science we teach in the classroom should be consistent with scientific inquiry, which is "activity-oriented learning that reflects scientific investigation, specifically the observation, experimentation, and reasoning used by scientists" (Chiappetta and Adams 46). The purpose of inquiry-based teaching in the science class is to enable the students to construct understanding about nature, to engage in active learning meant to help them reconstruct scientific knowledge and find meaning in it. Most scientists agree that utilizing inquiry-based science instruction in the classroom is very important for several reasons:

- Understanding of fundamental facts, concepts, principles, laws, and theories;
- Development of skills that enhance the acquisition of knowledge and understanding of natural phenomena;
- Cultivation of the disposition to find answers to questions and to question the truthfulness of statements about the natural world;
- Formation of positive attitudes toward science; and
- Acquisition of understanding about the nature of science.

(Chiappetta and Adams 47)

Among the different aspects of inquiry-based science instruction, I find the content with process (which focuses on constructing knowledge through active learning) and the process with content (which focuses on developing the students' ability and disposition to investigate) approaches most appropriate for the purpose of my curriculum unit. Sadly enough, what most of my students have been trained to expect from the science class is the content approach, which focuses on little more than presenting and explaining ideas (as if science in our elementary classrooms were nothing more than reading with a focus on non-fiction or expository texts!). Even in cases when the process approach is

preferred, many teachers will use a content-heavy method, covering a great deal of subject matter, occasionally sprinkled with experiments or laboratory exercises (Chiappetta and Adams 49). Throughout planning this unit, as well as carrying it out in my classroom, one question I must keep in mind is "To what extent am I using content with process and process with content in my teaching?"

IMPLEMENTATION STRATEGIES

The present unit is intended for use as part of the third grade science curriculum in my classroom. The lessons will focus on several objectives, as established by the Houston Independent School District, to conform with the Texas Education Agency (TEA).

Most of the activities proposed by this curriculum unit will provide (but will not be restricted to) ample opportunities for cooperative learning and discovery learning. Other situations will be more suitable for class discussion, individual research, or partner work. However, all the activities suggested here have one common strand: the students will be challenged at all times. They will be challenged to think (sometimes in patterns and ideas unfamiliar to them), to predict, to compare and analyze data, to discover, to dare to explore, and above all, to experience science through their own senses and mind, to live it rather than passively learn it. There will be opportunities for asking and answering questions, for making predictions and observations, hypotheses and inferences, for writing and creating.

Despite the focus on science present throughout my unit, the areas addressed will go beyond the scope and facts of science. I will try to bring this curriculum unit as close to teaching across disciplines as possible partly because I believe that there is no substitute for real life experience in true learning, and partly because I have often witnessed a greater success rate at the elementary level when teaching thematic units as compared to teaching distinct, separate units. The individual lessons will often use a story (whether read aloud by the teachers, or previously read by the students, as part of a classroom assignment) as a starting point for discussion. Video materials that might arouse the students' interest will also be part of the teaching materials (these will include carefully selected short movies, cartoons, documentaries, etc.), as well as actual objects that both students and teacher will bring to the classroom as exhibits, manipulatives, or "props." The scientific experiments will often appeal to math as well as writing skills, and the lessons will sometimes conclude with end products such as poems, posters, speeches, student-made books, dioramas, and other exhibits.

For a list of TEA objectives that I will be covering, please refer to the appendix at the end of this unit.

The Water Cycle

We will begin the unit with a discussion of the water cycle. Rather than simply exposing the students to a diagram of the water cycle in nature, we will first conduct simple

experiments in the classroom with boiling water that evaporates, followed by steam that condensates. I accidentally discovered a very easy way to prove condensation to elementary students when I once sprayed water on a hot overhead projector screen. Before the vapors had time to dissipate completely, I covered the overhead with a blank transparency: the students could observe how the vapors clouded the transparency and quickly turned into little drops of water at the contact with the cold surface. We will then discuss how water circulates and changes states in nature. (See Lesson Plan 1.)

At this introductory stage of our discussion of the water cycle, the students will have the opportunity to conduct a simple experiment we could call "water cycle in a baggie" (as developed in a personal communication during our seminars with Professor Widger). In this experiment, a clear cup, half-filled with water, is set in a Ziploc bag, together with a cotton ball on which several drops of food coloring have been placed (the cotton ball will be set *next to* the cup, not *in* it). The bag will be then zipped closed and set in a sunny window. Over the course of several days, the students will observe how the color from the cotton ball will gradually transfer to the water in the cup. They will explain this through evaporation and condensation.

One of the principles I will try to stay true to during this unit is that we learn as we experience. My students will get to understand how and why we use units of measurement such as volume, weight, and temperature while we are working on an experiment focusing on water evaporation. Over a period of several days, we will observe and measure how water evaporates in different amounts, depending on temperature and the open surface of the container. Aside from measurement, I will also integrate math by modeling representing data in graphs and then have the students create their own, according to their observations.

A wonderful way to get students engaged and offer them the opportunity of firsthand observation would be a terrarium built in our very classroom. I found a very useful model described in Eileen Lucas' book *Water: A Resource in Crisis*: a terrarium equipped with a tight fitting lid, consisting of several layers (a gravel layer at the bottom, followed by a layer of peat moss, then dirt) and small plants such as ferns and mosses. Over a time period of several days/weeks, the students will carefully observe how the water cycle within the aquarium will recycle the water in this mini-ecosystem over and over again (Lucas 17).

Water as a Resource

The unit will continue with a class discussion of water as a resource. The students will brainstorm and identify all uses of water in our world. They will see how water is what we drink, use every day, and are even mostly made of! An idea I found very useful for promoting awareness of water use (and often misuse and abuse) is to have each student do a water audit at home by checking the water meter every morning for a week and recording the daily quantities and variation (Lucas 41). This will give us an insight of

how much water is used in the average household on a daily basis. Aside from the obvious advantage of promoting awareness of water use, misuse, and abuse, this lesson will be an opportunity for my students to become familiar with the water meter, what purpose it serves, and how it is read. I am planning to do this in a previous introductory activity, using the meters located in the cafeteria (of course this will require prior permission from the administration, as well as locating the meters in the first place!).

During this stage of my unit, the students will work on research skills with a focus on social science. Several learning centers will be developed in the classroom, concentrating on oceans, lakes, rivers, sources of water pollution, and ways to prevent and remediate it. Each group of students will research one topic, collect information in learning logs, and organize it in varied ways (such as posters, display boards, journals, graphs, etc.) followed by reporting back to the class at the end of the week(s).

A fun experiment to help students understand that plants need water just like all living things is by using fresh white flowers (such as carnations) whose stems are cut and put in several glasses filled with food coloring and water. Over the course of a day, the students will be able to observe how the food coloring from the glasses transfers to the petals, turning the white flowers into vividly colored ones (Ardley 95).

Pollution and Water Pollution

We will go on with a class discussion of what pollution means. The students will brainstorm to come up with a comprehensive list of pollution factors and then categorize these factors according to the type of resource they affect (water, air, land). We will focus on water pollution.

A good way to start looking into water pollution would be by organizing a field trip to a wetland area somewhere around Houston, during which students would carefully observe all sources of water pollution present. They would record their observations and collect litter (as this represents one of the pollutants). We could discuss them and try to understand ways in which the pollutants affect the environment and how this can be prevented. I would also encourage my students to take a close look at the streets when it is raining: sometimes the sunlight reflects in rainbows, caused by the gasoline spilled by cars. An experiment we can conduct during rainy days is by using funnels with coffee filter paper to collect and filter rain water. Students will observe the filter paper after a day and notice how dirt or other particles have collected. This will provide a good setting for discussing measurement with my students. They will see how we use measurement when we collect and compare data such as the amount of water resulted during the rainfall over a period of several days.

We will continue in the classroom with a series of experiments and activities designed to look at various forms of water pollution and their effects on life. One activity would be an experiment in which students taste different clear liquids (such as sugar

water, white vinegar, lemon juice, salt water, tap water) to understand that not all pollution can be seen.

An experiment focusing on water pollution would be a reenactment of the Exxon-Valdez spill using several aluminum plates filled with water, in which a small amount of DW40 oil is poured (as developed in a personal communication during our seminars with Professor Widger). The students will then be challenged to come up with hypotheses over which the best way to clean the oil up is (by using string to "lasso" the oil spill, by using cotton balls, cloth, newspaper, or paper towels to clean the oil, or by adding dishwashing liquid to the oil and water). After formulating their hypothesis, the students will perform the experiment and record their observations. The experiment will prove the effectiveness (or rather lack of it) of various methods of cleaning oil cleanups when they occur. It will also prove water pollution to be irreversible once done. (See Lesson Plan 2.)

This will be a good point to bring into our discussion the Environmental Science Merit Badges from the Boy Scouts of America. There are often at least two or three children in every classroom who are part of the Boy Scouts or planning to join them. Throughout my unit and the actual teaching of it, I will keep a careful eye on every opportunity for my lessons to derive from and anchor in my students' daily lives.

As an extension to the Exxon-Valdez experiment, the students will look into how different materials in nature and coverings on animals are affected by oil spills. For this, we will first build a classroom model of a seashore area, by using a large baking pan in which we will form a sloping beach of sand. The students will then push various objects into the sand, such as a block of wood, a rock, a sea shell, feathers tied together, and a hunk of real fur. They will then fill the pan with water until the water level is halfway up the beach, and carefully pour ½ cup of oil at the water end. Using a flat stick as a paddle, the students will work in groups to create waves for several minutes and observe several things, such as: Does the oil stick to all objects? Which object is coated the most? Does the oil stay on the sand's surface? (Blashfield 55) As a follow up, the students will team up and try to remove the oil from the materials used in the experiment with cotton cloth, paper towels, detergent, newspaper, or hot water. This will create an opportunity for a class discussion on the direct effects of water pollution on the environment and ways in which people can help (99). (See Lesson Plan 3.)

Another experiment focusing on the effect of polluted water on plants would use several bean plants, watered daily with clean water, a solution of vinegar (to simulate acid rain), water mixed with oil, and a mixture of water, oil, and soap (the students could use here the water resulting form the Exxon-Valdez experiment). The students will observe the evolution of the plants over several days and write down their observations. This will help them understand how water pollution affects the environment. Math skills will be reviewed in this stage of my unit, such as addition and subtraction (to contrast and compare their findings, from a plant to another and across several days), and representing data in bar graphs will be introduced now.

After we have looked at various sources and types of water pollution and at their effects on life, my students and I will investigate ways to prevent or reverse pollution (in cases where reversal is possible). We will look at how water can be purified (for example by filtering muddy water through a funnel filled with a layer of small pebbles, covered by another layer of gravel, then sand) and also investigate ways to prevent water pollution from occurring or at least minimizing its effects on the environment.

At the end of the unit we will write "bio-poems" – a form of poetry writing that expands the students' ability to organize information they have acquired on a topic. We will create such poems for water, pollution in general, water pollution, and ways to make a difference in a polluted environment. (A bio-poem is a form of poetry consisting of several lines, where the first and the last lines announce and repeat the topic, such as "Water." The lines between refer to attributes of the topic, and they each begin with a letter from the topic word. For example, in a poem on water, the second line will begin with "W", the third line will begin with "A", the fourth with "T", and so on.)

The activities described above will enable students to understand water pollution and its potential effects on human and wildlife habitats, as well as its sources and possible solutions. This will be a good opportunity to introduce elementary students to environmental concerns. The students will get a chance to use the background knowledge they have of the world and to observe what surrounds them. This will help develop the students' sense of ownership of the world, which will in turn become a positive basis for action in their future life. My students will also profit from this unit by developing skills necessary to the scientific process, such as stating a problem, formulating a hypothesis, collecting data, interpreting it and organizing it into graphs, then formulating a conclusion. This would also be a wonderful opportunity for Science-Language Arts and Science-Art connections: students will come up with ideas for an environmental awareness campaign as well as develop their writing skills when creating a poster and other advertising materials for their campaign, or coming up with speeches to give in front of an audience.

LESSON PLANS

Lesson Plan 1: The Water Cycle

Objectives

ELA.R.3.02.e. Identify the features of expository text structure.
ELA.R.3.05.d. Summarize events or ideas from a text.
ELA.R.3.05.e. Identify causes and effects from a piece of text.
SCI.3.02.B. Collect information by observing and measuring.
SCI.3.02.C. Analyze and interpret information to construct reasonable explanations from direct and indirect evidence.
SCI.3.02.D. Communicate valid conclusions.

SCI.3.02.E. Construct simple graphs, tables, maps, and charts to organize, examine and evaluate information.

SCI.3.03.A. Analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information.

Materials needed

Overhead projector
Spray water bottle
Blank overhead transparency
One or several copies of *The Magic School Bus at the Waterworks*, by Joanna Cole and Bruce Degen.
Chart paper and markers

Procedure

I will open the lesson by asking the students what they think will happen if I spray water on a hot overhead projector screen. After a class discussion followed by recording their predictions, the students will observe what happens to the water sprayed on the hot screen. Before the vapors have time to dissipate completely, I will cover the overhead projector screen with a blank transparency: the students will be able to observe how the surface quickly clouds. I will ask them to explain what has happened, and gradually conduct the discussion to a point where they will understand that what we have just witnessed is water evaporating and quickly condensing at the contact with the cold surface.

We will then read the book *The Magic School Bus at the Waterworks*. The students will be surprised to find a similar discussion of the water cycle to what we just discovered in our simple experiment. We will later take time to discuss pages 14 through 19, since they refer to the water cycle. I will focus my students' attention on the features of the text and ask them to identify what type of text it is. This will also be a good time to talk about fictional and non-fictional elements in the story, cause and effect, as well as summarizing the main ideas.

We will now reread and discuss pages 14 through 19, and create a diagram of the water cycle. As a follow up (and to finish for homework), the students will be asked to duplicate a device that Joanna Cole uses in the story in order to include information. They will each come up with their own "Ten Water Facts." (Cole and Degen 11, 12, 14, 17, 19, 23, 27, 29, 31)

Lesson Plan 2: Cleaning an Oil Spill

Objectives

ELA.L.3.02.d. Use higher-order thinking skills and their associated language to participate in academic discussions and activities.

ELA.R.3.08.c.	Organize information in a systematic way.
ELA.W.3.08.a.	Write or dictate questions for investigation on a specific topic.
ELA.W.3.08.b.	Record information found through investigation.
MATH.3.14.A.	Collect, organize, record, and display data in pictographs and bar graphs where each picture or cell might represent more than one piece of data.
MATH.3.14.B.	Interpret information from pictographs and bar graphs.
SCI.3.01.A.	Demonstrate safe practices during field and laboratory investigations.
SCI.3.01.B.	Make wise choices in the use and conservation of resources and the disposal or recycling of materials.
SCI.3.02.A.	Plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology.
SCI.3.02.B.	Collect information by observing and measuring.
SCI.3.02.C.	Analyze and interpret information to construct reasonable explanations from direct and indirect evidence.
SCI.3.02.D.	Communicate valid conclusions.
SS.3.4.c.	Describe the effects of physical and human processes in shaping the landscape.

Materials needed

Several aluminum plates
DW40 oil
String, cotton balls, cloth, newspaper, paper towels, dishwashing liquid
Library resources, encyclopedias, internet access

Procedure

An experiment focusing on water pollution would be a reenactment of the Exxon-Valdez spill using several aluminum plates filled with water, in which a small amount of DW40 oil is poured (as developed in a personal communication during our seminars with Professor Widger). The students will be challenged to develop hypotheses over which the best way to clean the oil up is (by using string to "lasso" the oil spill, by using cotton balls, cloth, newspaper, or paper towels to clean the oil, or by adding dishwashing liquid to the oil and water). After formulating their hypothesis, the students will perform the experiment and record their observations.

The students will create charts from the information they recorded during the experiment and draw conclusions concerning the effectiveness of the methods employed.

Since the experiment will prove that water pollution is irreversible once it is done, the students will work in groups to find solutions this problem. They will focus on possible strategies to avoid water pollution and alternative forms of energy. The groups will then

conduct research through a variety of means (library books, internet, encyclopedias, etc.) on these issues.

Lesson Plan 3: Effects of Oil Spills

Objectives

ELA.L.3.02.d.	Use higher-order thinking skills and their associated language to participate in academic discussions and activities.
ELA.L.3.03.b.	Provide information acquired from a variety of sources (print and non-print).
ELA.R.3.08.c.	Organize information in a systematic way.
ELA.W.3.08.a.	Write or dictate questions for investigation on a specific topic.
ELA.W.3.08.b.	Record information found through investigation.
SCI.3.01.A.	Demonstrate safe practices during field and laboratory investigations.
SCI.3.01.B.	Make wise choices in the use and conservation of resources and the disposal or recycling of materials.
SCI.3.02.A.	Plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology.
SCI.3.02.B.	Collect information by observing and measuring.
SCI.3.02.C.	Analyze and interpret information to construct reasonable explanations from direct and indirect evidence.
SCI.3.02.D.	Communicate valid conclusions.
SCI.3.02.E.	Construct simple graphs, tables, maps, and charts to organize, examine and evaluate information.
SCI.3.08.C.	Describe environmental changes in which some organisms would thrive, become ill, or perish.
SS.3.4.c.	Describe the effects of physical and human processes in shaping the landscape SS.3.18.a. Use a problem-solving process.
SS.3.18.b.	Use a decision-making process.

Materials needed

A large baking pan (at least 2 inches deep)
Sand
Various objects found in nature, such as a block of wood, rocks, sea shells, feathers tied together, and a hunk of real fur
½ cup of DW40 oil
A flat craft stick
Cotton cloth, paper towels, detergent, newspaper

Procedure

As an extension to the Exxon-Valdez experiment, the students will look into how different materials in nature and coverings on animals are affected by oil spills. For this,

we will first build a classroom model of a sea shore area, by using a large baking pan in which we will form a sloping beach of sand. The students will then push various objects into the sand, such as a block of wood, a rock, a sea shell, feathers tied together, and a hunk of real fur. They will fill the pan with water until the water level is halfway up the beach, and carefully pour ½ cup of oil at the water end. Using a flat stick as a paddle, the students will work in groups to create waves for several minutes and observe several things, such as:

- Does the oil stick to all objects?
- Which object is coated the most?
- Does the oil stay on the sand's surface?

(Blashfield 55)

The students will record their observations and draw conclusions.

As a follow up, they will form teams in order to try and remove the oil from the materials used in the experiment with cotton cloth, paper towels, detergent, newspaper, or hot water. This will create an opportunity for a class discussion on the direct effects of water pollution on the environment and ways in which people can help (Blashfield 99).

APPENDIX

Reading/Language Arts Objectives

ELA.L.3.02.d.	Use higher-order thinking skills and their associated language to participate in academic discussions and activities.
ELA.L.3.03.b.	Provide information acquired from a variety of sources (print and non-print).
ELA.R.3.01.b.	Read with fluency and understanding in a variety of texts for a variety of purposes at appropriate difficulty levels.
ELA.R.3.02.a.	Recognize and distinguish a variety of text forms and genres.
ELA.R.3.02.e.	Identify the features of expository text structure.
ELA.R.3.05.c.	Identify stated main ideas and salient supporting details from a piece of text.
ELA.R.3.05.d.	Summarize events or ideas from a text.
ELA.R.3.05.e.	Identify causes and effects from a piece of text.
ELA.R.3.05.f.	Make inferences from a text.
ELA.R.3.05.g.	Distinguish fact from opinion in various texts.
ELA.R.3.06.b.	Compare and contrast texts.
ELA.R.3.06.c.	Respond to text.
ELA.R.3.08.c.	Organize information in a systematic way.
ELA.W.3.08.a.	Write or dictate questions for investigation on a specific topic.
ELA.W.3.08.b.	Record information found through investigation.

(Reading/Language Arts, Grade Three, 2002 Houston Independent School District)

Math Objectives

MATH.2.05.B.	Use patterns in place value to compare and order whole numbers through 999.
MATH.3.03.B.	Select addition or subtraction and use the operation to solve problems involving whole numbers through 999.
MATH.3.11.A.	Estimate and measure lengths using standard units such as inch, foot, yard, centimeter, decimeter, and meter.
MATH.3.12.B.	Use a thermometer to measure temperature.
MATH.3.13.A.	Measure to solve problems involving length, area, temperature, and time.
MATH.3.14.A.	Collect, organize, record, and display data in pictographs and bar graphs where each picture or cell might represent more than one piece of data.
MATH.3.14.B.	Interpret information from pictographs and bar graphs.
MATH.3.15.A.	Identify the mathematics in everyday situations.
MATH.3.15.C.	Select or develop an appropriate problem solving strategy, including drawing a picture, looking for a pattern, systematic

	guessing and checking, acting it out, making a table, working on simpler problem, or working backwards to solve a problem.
MATH.3.15.D.	Use tools such as real objects, manipulatives, and technology to solve problems.
MATH.3.16.A.	Explain and record observations using objects, words, pictures, numbers, and technology.
MATH.3.17.A.	Make generalizations from patterns or sets of examples and non-examples.

(Math, Grade Three, 2002 Houston Independent School District)

Science Objectives

SCI.3.01.A.	Demonstrate safe practices during field and laboratory investigations.
SCI.3.01.B.	Make wise choices in the use and conservation of resources and the disposal or recycling of materials.
SCI.3.02.A.	Plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology.
SCI.3.02.B.	Collect information by observing and measuring.
SCI.3.02.C.	Analyze and interpret information to construct reasonable explanations from direct and indirect evidence.
SCI.3.02.D.	Communicate valid conclusions.
SCI.3.02.E.	Construct simple graphs, tables, maps, and charts to organize, examine and evaluate information.
SCI.3.03.A.	Analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information.
SCI.3.03.C.	Represent the natural world using models and identify their limitations. SCI.3.03.D. Evaluate the impact of research on scientific thought, society, and the environment.
SCI.3.04.A.	Collect and analyze information using tools including calculators, microscopes, cameras, safety goggles, sound recorders, clocks, computers, thermometers, hand lenses, meter sticks, rulers, balances, magnets, and compasses.
SCI.3.08.C.	Describe environmental changes in which some organisms would thrive, become ill, or perish.

(Science, Grade Three, 2002 Houston Independent School District)

Social Studies Objectives

SS.3.4.c.	Describe the effects of physical and human processes in shaping the landscape.

SS.3.15.	Identify significant scientists and inventors in specific fields and describe their impact on new technology.
SS.3.16.a.	Acquire historical and geographical data about the community using a variety of print, oral, visual, and computer sources.
SS.3.16.b.	Sequence and categorize information.
SS.3.16.c.	Interpret oral, visual, and print materials by identifying the main idea, identifying cause and effect, and comparing and contrasting.
SS.3.16.d.	Locate information by using various parts of a source.
SS.3.16.e.	Interpret and create visuals.
SS.3.16.f.	Use appropriate mathematical skills to interpret social studies information.
SS.3.18.a.	Use a problem-solving process.
SS.3.18.b.	Use a decision-making process.

(Social Studies, Grade Three, 2002 Houston Independent School District)

ANNOTATED BIBLIOGRAPHY

Works Cited

Ardley, Neil. *101 Great Science Experiments*. New York: Dorling Kindersley, Inc., 1993
This book describes 101 science experiments or activities that can be done with household items and easily found ingredients.

Blashfield, Jean F. and Wallace B. Black. *Oil Spills*. Chicago: Children's Press, 1991
This book describes how an oil spill occurs; the damaging effects of recent spills on the sea, land, and wildlife; and the difficult process of cleaning up after a spill. It is a good source of information for the teacher rather than reading material for the class.

Chiappetta, Eugene L. and April D. Adams. "Inquiry-Based." In *The Science Teacher*, National Science Teachers Association, Vol. 71, No. 2, February 2004, pg. 46
This article looks at how content and process go hand-in-hand with school science.

Lucas, Eileen. *Water: A Resource in Crisis*. Chicago: Children's Press, 1991.
This book describes how human actions and carelessness are polluting Earth's water supply and what can be done to clean it up.

Supplemental Resources

Broekel, Ray. *Experiments With Water*. Chicago: Children's Press, 1988.
This book contains a variety of experiments demonstrating the properties of water. I found it very useful for the introductory stage of my unit, when students are discussing water cycle and forms.

Chevat, Richard. *The Magic School Bus: Science Explorations*. New York: Scholastic Inc., 1994.
This book proposes a series of exciting science ideas and projects, very appropriate for elementary students.

Cole, Joanna and Bruce Degen. *The Magic School Bus at the Waterworks*. New York: Scholastic Inc., 1986.
The book looks at the states of water and water cycle in nature, as well as the purifying water process.

Dew, Lucille, et al. G*uide to Teaching Writing*. Houston, TX: 2004.
This writing guide explains in detail how to teach certain forms of writing to K-8 students, such as the bio-poem. These can be successfully used as extensions and Science – Language Arts connections when teaching this unit.

Donnelly, Andrew. *Water Pollution.* The Child's World, 1999.
Questions and answers introduce the basics of water pollution, its causes, effects, and prevention. The exciting pictures and the simple language make this book a very good start for a read-aloud.

Foster, Betty, et al. *Creative Science for Young Children.* Elgin, IL: The Child's World: 1998.
This book features hands-on projects that let young students experience the joy of discovery and learning, making science an enjoyable experience. It is a year-round collection of science ideas, which can be easily correlated with the seasons or other events.

Harlow, Rosie and Sally Morgan. *Pollution and Waste*. New York: Kingfisher Publications, 2001.
The book looks at pollution and waste, proposing a set of experiments and actions children can take to better care for the environment.

Jefferies, David. *Water.* Huntington Beach, CA: Teacher Created Materials, Inc., 1993.
This book is a thematic, whole-language based unit that will deepen the students' understanding of how important water is to life on Earth and why it is necessary to take care of this vital resource. The book proposes a series of demonstrations that clarify the properties of water.

Jensen, Eric. *Teaching with the Brain in Mind*. Alexandria, VA: ASCD, 1998.
This book deals with the psychological and cognitive aspects of learning and teaching, by providing the latest practical and easy-to-understand research on the brain. A truly revolutionary book for the educator trying to better reach students through brain-compatible teaching and learning.

Kerrod, Robin. *Fire and Water.* New York: Marshall Cavendish Co., 1990.
More projects and activities that explore different aspects of water, as well as fire.

Leggett, Dennis and Jeremy. *Troubled Waters.* New York: Marshall Cavendish Co., 1991.
This book examines the ways in which humanity is poisoning the waters of our planet and how this pollution can be stopped. Its format, very close to that of a science magazine for children, makes it an appealing classroom resource. Good source of short articles with diagrams and fast facts, as well as suggestions for further reading and useful addresses.

Leggett, Jeremy. *Waste War.* New York: Marshall Cavendish Co., 1991.
This book looks at different and increasing levels of waste produced by industry and society, including toxic and nuclear waste and ocean dumping. The same

exciting magazine style makes this book a valuable resource for classroom reading. Good resource for investigating waste and its effects.

Sterling, Mary Ellen. *Oceans.* Huntington Beach, CA: Teacher Created Materials, Inc., 1990.
This book is a thematic, whole-language based unit about the seas. It contains exciting suggestions for cooperative learning, curriculum connections, group projects, and writing ideas.

_____. *Our Environment.* Huntington Beach, CA: Teacher Created Materials, Inc., 1991.
This book is a thematic, whole-language based unit about the environment. It contains exciting suggestions for cooperative learning, curriculum connections, group projects, and writing ideas.

Stille, Darlene R. *Water Pollution.* Chicago: Children's Press, 1990.
This book discusses the benefits of water, its pollution, and the harmful effects of avoiding water pollution. Very approachable for lower elementary grades, good for a read-aloud when introducing pollution.

Zike, Dinah. *Big Book of Books and Activities*. San Antonio, TX: Dinah-Might Activities, Inc., 1994.
A great resource for teachers who want to go beyond fill-in-the-blanks activities; it gives suggestions for hundreds of action learning aids that incorporate reading and writing, math and science, map skills, critical thinking skills, all in the shape of craft projects.

Web Resources

Earthguide Diagrams: Water Cycle. 2004. Univ. of California – San Diego.
<http://earthguide.ucsd.edu/earthguide/diagrams/watercycle>
An excellent animated water cycle diagram, with carefully labeled elements.

Kimball, Joel. *Drippy the Raindrop's Water Cycle Adventures.* 2003. Kimball Media.
<http://www.kimballmedia.com/Drippy>.
A very children-friendly website, containing the fun tale of adventures of Drippy the Rainbow. Most sources are available on this site for a fee, but there are also good free resources for teachers.

Matter Cycles: The Water Cycle. Dr. Art's Guide to Planet Earth.
<http://www.planetguide.net/book/chapter_2/water_cycle.html>
This is a very useful site for teaching the water cycle: it includes 3 different animated water cycle diagrams, according to the level of the students (beginner, intermediate, advanced).

The Water Cycle. 2004. BrainPOP.com LLC. <http://www.brainpop.com/science/ecosystems/watercycle/index.html>.
This site is an exciting source of movies, quizzes, and science facts about water and its cycle in nature.

The Water Cycle at Work. 2004. Environmental Protection Agency. <http://www.epa.gov/OGWDW/kids/cycle.html>
This site offers science and health games and activities for K-12 students, as well classroom activities and experiments. The animated water cycle is a good way of presenting this information to elementary students.

In contrast to older methods of science instruction, which emphasized lectures to efficiently present scientific information and encouraged students to memorize facts from textbooks, examination of today's scientific instructions quickly reveals an emphasis on problem solving, inquiry-based laboratory activities and the rejection of science as a body of facts that must be memorized (Stuart & Henry, 2002).Â Constructivist teaching methods, in which inquiry-based instructional strategies are emphasized, have received much attention nationally (Brooks & Brooks, 1993). These methods, guided by principles of the learning cycle, allow students to explore and develop scientific concepts while completing meaningful activities (Lawson, 2000). Inquiry-based learning (also enquiry-based learning in British English) is a form of active learning that starts by posing questions, problems or scenarios. It contrasts with traditional education, which generally relies on the teacher presenting facts and his or her knowledge about the subject. Inquiry-based Learning is often assisted by a facilitator rather than a lecturer. Inquirers will identify and research issues and questions to develop knowledge or solutions. Inquiry-based learning includes