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An enrichment unit on local water resources and water conservation to supplement eighth grade earth science curriculum

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AN ENRICHMENT UNIT ON LOCAL WATER RESOURCES AND WATER CONSERVATION TO SUPPLEMENT EIGHTH GRADE EARTH SCIENCE CURRICULUM

by
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ABSTRACT

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1996

PROFESSOR F. GARY PATTERSON

MASTER OF ARTS DEGREE IN ENVIRONMENTAL EDUCATION

Currently, there is no written curriculum for educating students about local water resources and water conservation practices in the Glassboro Eighth Grade Earth Science Curriculum. Utilizing all available references and agencies, (federal, state and local) the author created an enrichment unit dealing with local water resources and water conservation practices to supplement the existing Eighth Grade Science Curriculum, specifically the Geology unit of the Merrill Earth Science text book. The lessons are hands-on activities which promote critical thinking, problem solving, and cooperative learning. Though designed for a specific audience and for a specific reason, lessons in the unit can be easily adapted by any teacher to incorporate environmental education activities in their classrooms.

MINI ABSTRACT

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The objective of this thesis was to develop an enrichment unit on local water resources and water conservation practices to supplement the Geology unit of the Merrill Earth Science textbook used in the Glassboro Eighth Grade Science Curriculum. The completed project provides an effective tool for teaching and learning about local water resources and water conservation practices through hands-on activities.

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To Mom, for showing me, by example, exactly what "women's work" should be

To Troy, for being my tower of strength and support during this project, I Love You!

To Jackie and Troy, for understanding when Shelli couldn't go out to play

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CHAPTER ONE

Introduction

"Water, water everywhere and not a drop to drink," the title of an ANJEC forum the author attended in preparing this proposal as well as what many New Jersey residents consider to be the truth about the state of their drinking water. In Gloucester County alone, there exists known salt water intrusion; there is the potential for salt water intrusion; the chloride concentration has at times exceeded 250 mg/l in the Potomac/Raritan/Magothy aquifer, and between 11-25 wells tested contain contaminated water. (Ayers and Pustay, 1986) Because of these issues as well as the fact that the water level in the PRM aquifer has dropped fifty feet since 1968 due to overpumping, part of Gloucester County has been labeled as Critical Water Supply Management Area #2, more simply known as Critical Area #2. ("USGS Fact Sheet," 1995) In response to this serious problem, NJDEP mandated a reduction in pumping from the PRM aquifer by 1996. (Dooley, 1995)

Glassboro lies within Critical Area #2. The Glassboro Water and Sewer Department searched for an independent solution to the problem, one which precludes reliance on New Jersey-American Water Company. (Dooley, 1995) Glassboro would decrease its reliance on the PRM aquifer by pumping water from the Kirkwood-Cohansey aquifer instead and purifying the water with a new three million dollar water treatment plant. (Dooley, 1995)

Although this alternative would be less expensive than going with water pumped from the Delaware River by the New Jersey-American Water Company, Glassboro residents will most likely see their water bills double. (Manganaro, 1995) Glassboro Mayor Todd Armstrong and Superintendent of the Water and Sewer Department, John Manganaro, see this as an excellent opportunity to reeducate the public about water resources and water conservation issues.

John Manganaro concludes from experience in educating Glassboro residents about water quality issues, the best way to educate the public is through the schools. Many professionals in the environmental education field have concluded that the best way to get environmental topics into the school curriculum is by integrating them into the existing curriculum. (Iozzi 1989 and Simmons 1989) The author will attempt to make Earth

Science recent and relevant to students' lives by infusing an enrichment unit on local water resources and water conservation practices into the existing Eighth Grade Earth Science curriculum.

Statement of the Problem

At this time, there exists a recognized need to supplement the Glassboro Eighth Grade Science curriculum with an enrichment unit on local water resources and water conservation practices. (Manganaro, 1995)

Purpose of the Study

The purpose of this project will be to develop a series of enrichment activities dealing with local water resources and water conservation practices to supplement the existing Glassboro Eighth Grade Science Curriculum.

Significance of the Study

Environmental Education should aim not only to impart knowledge, but also to change behaviors, to give students the power to become responsible citizens environmentally. (Hungerford and Volk, 1990) In order to do that, they must already have positive environmental attitudes and values in place. Iozzi (1989) thinks the best time to do this is during the elementary/middle school years. McInnis generalizes that humans learn best when what they learn contributes to their own needs. (Engleson and Yockers, 1994) The development of this enrichment unit is significant because having enough clean water to drink is something everyone needs. They are learning this, according to Iozzi (1989) at the best time for them to develop positive attitudes about conserving water and preventing further water contamination. Backed with the necessary knowledge and positive attitudes this unit will attempt to impart, these students will be better prepared to make decisions regarding water quality issues in their town.

Assumptions

1. That there exists a need for this type of project in Glassboro Intermediate School.
2. The author has adequate experience necessary to produce the project.
3. Students will have a better knowledge base and more positive attitude toward water quality issues as a result of this unit.
4. The unit will be used in the Glassboro Intermediate School.

Limitations

1. Reliance on people in the municipal water department, county planning board and USGS for accessible, reliable research data.
2. Enrichment unit developed will be relevant to the Glassboro area only.
3. Enrichment unit developed will be limited by the objectives of the existing Glassboro Eighth Grade Science Curriculum.
4. Enrichment unit will be limited by available facilities, curriculum materials and equipment and by budget constraints.

Definitions

Behavioral Objectives: "statements describing what learners are doing when they are learning. The behavioral objective has three essential elements: 1) an observable action must be named that shows that learning has taken place, 2) important conditions under which behavior is expected to occur should be described, and 3) the criteria of acceptable performance should be specified." (Bondi & Wiles, 1989, p. 89)

Curriculum: "planned and guided learning experiences and intended outcomes, formulated through systematic reconstruction of knowledge and experience, under the auspices of the school for the learners' continuous and willful growth in personal-social competence." (Tanner & Tanner, 1975, p. 45)

Enrichment: "the study of a new topic not presently part of the student's program." (Pratt, 1980, p. 348)

Environmental Education: "a model of action in which individuals and the community gain awareness of their environment and acquire the knowledge, values, skills and experiences and also the determination which will enable them to act - individually and collectively - to solve present and future environmental problems." (UNESCO, 1987, p. 2)

Environmental Education Infusion: "to permeate the entire curriculum with every subject area at every grade level dealing with the environment in some way." (Engleson in Simmons, 1989, p. 15)

Learning activity: "what pupils will do - both inside and outside of the classroom - to achieve the program's objectives." (Bank et al, 1981, p. 41)

Responsible Environmental Behavior: "any action, individual or group, directed toward the remediation of environmental issues/problems." (Sivek, 1987, p. 30)

CHAPTER TWO

Review of the Related Literature

Creating an effective, usable environmental education enrichment curriculum guide entails much more preparation, planning, and research than the author ever imagined. There are many "experts" out there who have much to say about environmental education. As the literature review became quite extensive, the author decided to organize it into three main categories for convenience and easy readability. The literature review has been divided into the following three parts:

I. The Research
II. The Implications of the Research on Curriculum
III. Review of Similar Projects

I. The Research

While there may be as many purposes of environmental education as there are opinions, quite a few experts in the field describe the purpose as creating a responsible environmental citizenry. The objectives outlined in the 1977 Tbilisi Intergovernmental Conference on Environmental Education aimed for responsible environmental behavior. (Hungerford & Volk, 1990) The World Commission on Environment and Development states that environmental education must "foster a sense of responsibility for the state of the environment and teach students how to monitor, protect, and improve it." (Westing, 1993, p. 5) The goal of the New Jersey Environmental Education Committee in its document, Environmental Education in New Jersey: A Plan of Action, is to develop an environmentally responsible citizenry.

What is an environmentally responsible citizen? Hungerford and Volk (1990) list the following characteristics to describe one. An environmentally responsible citizen: (1) is aware and sensitive to the environment and its problems; (2) understands the environment and its problems; (3) is concerned and motivated to participate in improving and protecting the environment; (4) has skills for identifying and solving environmental problems; (5) will be actively involved in resolving environmental problems.

If the goal of environmental education is a responsible environmental citizen, where and

how should it be taught? Senator Quentin Burdick, (1990) who first introduced the National Environmental Education Act, states the most natural place to start educating the public about environmental issues is in the classroom. According to the World Commission on Environment and Development, environmental education should be included in all subject disciplines at all levels across the whole school curriculum. (Westing, 1993) Simmons (1989) concludes students will learn to act as environmentally responsible citizens when environmental objectives are infused throughout the curriculum. Professionals throughout the environmental education field tend to agree that environmental education should start in the schools and rather than be taught as a separate entity, it should be incorporated into the existing curriculum.

Hungerford and Volk (1990) reviewed the results of several research studies which indicated environmental citizenship depended primarily on three variables. The development of these variables differs drastically from the traditional view that having environmental knowledge leads to awareness which leads to environmental action. The research does not support this linear approach. (Hungerford & Volk, 1990) What the research does indicate is a much more complex relationship between the three variables affecting environmental citizenship, the entry-level variables, the ownership variable and the empowerment variable.

Entry-level variables are those which improve decision making. Examples of entry-level variables are: environmental sensitivity, knowledge of ecology, attitudes toward pollution, technology and economics. (Hungerford & Volk, 1990) Ownership variables make the issues become personal, a factor critical to environmental behavior. Examples of ownership variables include in-depth knowledge of the issues, and personal investment. (Hungerford & Volk, 1990) Empowerment variables have to do with an individual knowing that she can make changes and solve problems. Examples of empowerment variables are: perceived skill in using environmental action strategies (if I can, I will), knowledge of environmental action strategies, locus of control (how will this behavior be reinforced?), and intention to act. (Hungerford & Volk, 1990)

Simmons has taken the environmental behavior model developed by Hungerford and

Volk and simplified it further. She finds the factors which play an integral role in the development of responsible environmental behavior are: knowledge of the issues and natural systems, problem solving skills, and psychological factors such as attitudes and self esteem. (Simmons, 1991) These factors must not only be addressed in the environmental education curriculum, they must be developed as program goals. (Simmons, 1991)

Newhouse's (1990) viewpoint on this issue is not very far off from Simmons'. She cites locus of control, responsibility, knowledge and attitudes as the most important factors for influencing environmental behavior. Her review of the research literature has found that while knowledge of the issues is a necessary foundation for the development of environmentally responsible behavior, it doesn't ensure future responsible environmental action or commitment. One's locus of control, or one's perception of his or her ability to initiate changes greatly impacts environmental behavior. (Newhouse, 1990) Hungerford and Volk describe locus of control as an empowerment variable. A person can have an external locus of control; feeling that he has no power over anything-- only larger entities do-- like God or municipal officials. (Newhouse, 1990) On the other hand, a person can have an internal locus of control, feeling that she does have the power to initiate change. (Newhouse, 1990) Research indicates those with internal locus of control are more likely to participate in environmentally responsible behaviors. (Newhouse, 1990) Newhouse points out that parents and teachers can help establish an internal locus of control in children. Giving kids a say, allowing them to make some of their own decisions, and having them evaluate the opinions of others, are three strategies that can be used to promote development of an internal locus of control which may, in turn, positively affect environmental behavior. (Newhouse, 1990)

While other authors seem to place equal emphasis on the variables which affect responsible environmental behavior, Newhouse (1990) endorses attitude, a positive or negative feeling about an object, people or issue, as the single most important influence on environmental behavior, especially in the area of environmental conservation. However, research shows a very shaky relationship between attitude and behavior. Newhouse (1990) cites the research of Hines which shows a small, positive correlation between attitude and

ensuing behavior. Overall, little evidence exists to confidently state that having the appropriate environmental attitude results in taking the appropriate environmental action. (Newhouse, 1990)

The attitude-behavior relationship is probably so hard to pinpoint because so many factors affect it. For example, temporal instability can affect it; the longer the time of collection between two sets of data, the less consistent the results. Direct experience versus indirect experience may impact the attitude/behavior model. More direct experiences may result in more attitudinal change than less direct experiences. Normative influences can affect a person; one may have the correct attitude but not act on it because of social influences. Lastly, the possibility can be entertained that attitudes and behaviors just don't relate well to each other. (Newhouse, 1990) The above factors summarize the inconcreteness of the attitude/behavior correlation.

Studies do indicate that one forms environmental attitudes because of certain life experiences. (Newhouse, 1990) A person may have a love of and willingness to protect the wilderness because he spent a lot of time camping while growing up. The environment where a person grew up contributes to the formation of environmental attitudes. (Newhouse, 1990) Experiencing a sense of loss influences conservation attitudes. (Newhouse, 1990) The good news is, studies have also shown that mere exposure to an environment can result in attitudinal change. (Newhouse, 1990) So although a person may not have had a previous life experience to lead to a certain attitude, exposure at this point may well produce a change in attitude.

Iozzi (1989) also adheres to the belief that simply possessing knowledge isn't enough to induce action, the right attitude also has to be present. That is why he strongly stresses that environmental education must be equally directed toward the affective domain as the cognitive domain. The affective domain has to do with values and value systems and is the "gateway" to the learning process. (Iozzi, 1989) Often through environmental education, teachers strive to impart positive environmental values and attitudes upon their students; to accomplish this, it is imperative to cater to the affective domain. (Iozzi, 1989)

Through his review of the literature, Iozzi summarized eight major ideas linking the

affective domain and environmental education. Attitudes are learned responses, therefore environmental education programs must be specifically designed to teach positive environmental attitudes and values. In comparison of an outdoor affective unit to a more traditional cognitive one, the affective unit produced more changes in attitude. (Iozzi,1989) As discussed earlier, the research indicates an unclear relationship between knowledge and attitudes. (Iozzi, 1989) Environmental educators cannot rely on knowledge alone to bring about attitudinal change. As knowledge does not necessarily lead to positive environmental attitudes, environmental education programs must teach positive environmental attitudes utilizing the affective domain.

Research shows once a student develops positive environmental attitudes/values, they appear to last. (Iozzi, 1989) Teachers tested after a two year lapse between the test and the workshop showed a loss in knowledge but they had maintained their positive attitudes. When puppetry was used to teach fourth graders environmental content as well as environmental values, after three weeks students showed a significant increase in the affective domain but a decrease in the cognitive domain. (Iozzi, 1989) Because attitudes are formed in the early years, attitude/value development must begin before kindergarten yet continue through all other levels. Attitudes of eighth graders are not significantly different from adults. Although the level of education seems to be important in the formation of environmental attitudes, the relationship between environmental attitudes and age, socioeconomic status, residence, and gender is inconclusive. (Iozzi, 1989) Starting at a very young age, all children should be taught positive environmental attitudes and values.

Research indicates several different strategies are effective for teaching in the affective domain. The most important strategy is to get the students outside. In a study, participants' attitudes toward the wilderness were more positive after direct experience with it. (Iozzi, 1989) Important to consider also is the fact that the media can influence environmental attitudes. Most students claim they receive their environmental information first from TV, second from science class and then third from periodical literature. (Iozzi, 1989) Most researchers, Hines, Hungerford and Volk, Iozzi, just to name a few, include the formation of environmental attitudes and values somewhere in their

treatment of environmentally responsible behavior. Serious thought and careful planning in regard to environmental attitudes and values by environmental educators must be undertaken if they wish to produce a successful environmental education program.

In Wisconsin, where environmental education is mandated, much time, effort, and research has been put into the development of an effective curriculum guide for environmental education. The resulting document, A Guide to Curriculum Planning in Environmental Education, was published by the Wisconsin Department of Public Instruction. According to the guide, the goal of environmental education is to "help students become environmentally aware, knowledgeable, skilled, dedicated citizens who are committed to work, individually and collectively, to defend, improve and sustain the quality of the environment on behalf of present and future generations of all living things." (Engleson & Yockers, 1994, p. 14) Simplifying this mission goal further, in the area of environmental education, educators must strive to develop in students: perceptual awareness, knowledge, an environmental ethic, citizen action skills, and citizen action experience. (Engleson & Yockers, 1994) While this guide may familiarize educators with key concepts regarding environmental education and actual techniques that can be used to obtain the goal, educators must bear in mind some basic underlying principles outlining how children learn. For example, if the educator is developing a curriculum guide for eighth grade students, she must be aware of the students' individual learning styles, the group's learning style and characteristics, and what experiences and prior knowledge they have brought with them up to this point in time. (Engleson & Yockers, 1994) Developing a curriculum guide for environmental education requires a thoughtful, carefully planned outline of not only what content should be learned, but also researching how the subjects should best learn it and when they will be best equipped mentally to learn it.

The goal of environmental education should lead to developing appropriate environmental behavior, state Engleson and Yockers (1994) and should begin with developing perceptual awareness in young children. In kindergarten through grade three, children should be learning to gather information using their senses. Students who have achieved a lower level of perceptual awareness should be able to describe an object using a

one word description, such as water is clear or the pond is small. As perceptual awareness develops, students should be able to describe an object using several characteristics, to group like objects, count how many of the same kinds of objects are in a certain area, measure the physical aspects of an object, and put events in the proper order, such as observing a blooming flower and a wilting flower and determining which occurred first. The highest level of perceptual awareness requires inferring, or having students make conclusions about their observations. (Engleson & Yockers, 1994) For example, when a child sees a wilted flower, the child will not only recognize and describe it, but can also offer a suggestion as to why it has wilted. While Engleson and Yockers stress perceptual awareness in the early grades, they don't ban it for the older student. It is conceivable that older students may not have had the opportunity to develop perceptual awareness. If not, they must be given the opportunity to do so or they will not be able to reach the next subgoal of constructing knowledge. (Engleson & Yockers, 1994)

Logic dictates if the goal of environmental education is for students to make appropriate, positive decisions for the environment, they must be environmentally literate. Fundamentally, students must have knowledge about the interworkings of the natural environment, how man interacts with the environment and how man can balance his needs and desires with a healthy environment. (Engleson & Yockers, 1994) Too much knowledge regarding the environment focuses on facts. Engleson & Yockers suggest getting away from the limitations of "discrete facts" in environmental education. (p. 20) They want to see educators reaching for the highest level of the Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook 1: Cognitive Domain by Bloom. These highest levels stress knowledge of principles, generalizations, theories and structures. (Engleson & Yockers, 1994) The knowledge factor is so important because with it, children can proceed from perceptual awareness to conceptual awareness. (Engleson & Yockers, 1994)

When it comes time for making decisions regarding the environment, students will rely not only on the knowledge they have acquired but on the environmental ethic they have developed. An ethic can be defined as a set of beliefs, attitudes and values which leads a

person to decide what is right or wrong. (Engleson & Yockers, 1994) These beliefs, attitudes and values can change over a person's lifetime. Caduta doesn't believe children up to grade six or age 12 have the ability to develop a personal environmental ethic. (Engleson & Yockers, 1994) Teenagers, however are just beginning to develop one; they have the ability to make moral decisions. Affective domain objectives should be included in the curriculum guide to give students the opportunity to fully develop an environmental ethic. (Engleson & Yockers, 1994) The affective domain objectives from the Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook II: Affective Domain dealing with an environmental ethic include: valuing, organization, and characterization by a value or value complex. (Engleson & Yockers, 1994, p. 37) For the goal of environmental education to be fully met, curriculum guides must address the issue of the development of an environmental ethic. Including affective domain objectives which will lead students to analyze their own and others' attitudes, and compare their attitudes to what is best for the environment is a step in the right direction.

Every citizen has the right to make an environmental decision but without the necessary skills of how to solve a problem, appropriate environmental decisions cannot be made. This is why Engleson and Yockers have citizen action skills as a subgoal for environmental education. Students must learn strategies for solving problems to be effective problem solvers. The major emphasis in middle school should be on communication skills and working cooperatively as a group. As teachers lead investigations of environmental issues to teach students how to resolve problems, the issues should be real, concrete and local. This creates motivation and students get to see the results of their work. (Engleson & Yockers, 1994)

Prospective teachers receive three and one half years of pre-service training. If they didn't also have the opportunity to actually practice what they had learned and experience a real school setting, the pre-service training could have been for nothing. The training is meaningless without the actual work experience. The same goes for applying one's citizen action skills to remediate environmental problems. If no actual experience is undertaken, students will be less likely to participate in environmental action. (Engleson & Yockers,

1994) Thus, at the high school levels, hopefully when all the other subgoals are in place, environmental education curriculums should now focus on citizen action experience. (Engleson & Yockers, 1994) Students must be given the opportunity to become directly involved in a local environmental issue. Hungerford suggests the following methods to allow students to gain citizen action experience by persuasion (letter writing), consumer action (refusing to buy a certain product), political action (voting), legal action (lawsuits), and ecomanagement (constructing a nature trail). (Engleson & Yockers, 1994) Along with the direct experience, curriculum guides should teach students how to decide if action is really necessary and then how to evaluate the effectiveness of the action after it has taken place. (Engleson & Yockers, 1994)

The eighth grade level is the grade level of the curriculum guide this author is preparing. According to Engleson and Yockers (1994), research data regarding cognitive and moral development of youngsters must be considered first. Students by this age have already achieved a highly developed sensory system. They are probably at Piaget's formal operational stage of learning, just beginning to think abstractly. The educational objectives which should be implemented according to Bloom's Taxonomy should be at the application, analysis and synthesis stages. The students are most likely in stage three or four of their value development and the affective domain objectives that should be concentrated on are those that deal with valuing, organization, and characterization by a value or value complex. Curriculum guides for this age level should have a major focus on knowledge, environmental ethic and citizen action skills. A minor emphasis is placed on perceptual awareness and citizen action experience. (Engleson & Yockers, 1994)

Often environmental education can be seen quite easily as a branch of science class. (Engleson & Yockers, 1994) While professional environmental educators would like to see environmental education infused into science class, most don't think it should be treated solely as a science subject, but infused throughout the entire curriculum. However, there do exist some logical links to show the comparibility between environmental education and science education. A Guide to Curriculum Planning in Science lists the following four major components of a science education program: problem solving, science knowledge,

nature of science, and science/technology/society. (Engleson & Yockers, 1994) Problem solving skills learned in science class are essential skills required to employ citizen action skills. The kinds of skills learned in science -- problem solving, observing, measuring, describing data -- are the same kinds of skills involved in the perceptual awareness subgoal of environmental education. (Engleson & Yockers, 1994) As with the knowledge subgoal of environmental education, the scientific knowledge component of science education attempts to focus on concept development such as diversity, change, interaction, organization, rather than on isolated scientific facts. (Engleson & Yockers, 1994) Investigating environmental issues, a strategy for acquiring citizen action skills, is similar to scientific investigations, a component for understanding the nature of science. (Engleson & Yockers, 1994) Lastly, the science/technology/society component looks at the relationship between the three entities and involves teaching students to make decisions regarding technology/science related issues to become more effective citizens. This parallels the purpose of the citizen action skills subgoal for environmental education. (Engleson & Yockers, 1994) Perhaps environmental education is always closely associated with science education because there are so many fundamental similarities between the two.

II. The Implications of the Research on Curriculum

"In the end, we will conserve what we love, we will love what we understand, and we will understand what we are taught." (Baba Dioum in Estes, 1993, p. K6) As a result of the many studies into environmental education, researchers have devised plans for implementing environmental education in the classroom. They proffer guidelines for developing curriculum guides and programs in environmental education. The key for educators introducing environmental education into their classrooms seems to be to remember that what they are teaching and what they want students to learn should lead to environmentally responsible citizenship.

Hungerford and Volk (1990) cite the necessity of identifying the variables related to environmental behavior, entry-level, ownership, and empowerment, as by identifying them, educators recognize the skills involved for each variable. These skills can be taught.

However, educators often do not accomplish this task, especially in the area of empowerment. Hungerford and Volk (1990) name the following as critical educational components for changing learner behavior, i.e., to increase environmental citizenship in students:

1. teach environmentally significant ecological concepts and the environmental interrelationships that exist within and between these concepts;
2. provide carefully designed and in-depth opportunities for learners to achieve some level of environmental sensitivity that will promote a desire to behave in appropriate ways;
3. provide a curriculum that will result in an in-depth knowledge of issues;
4. provide a curriculum that will teach learners the skills of issue analysis and investigation as well as provide the time needed for the application of these skills;
5. provide a curriculum that will teach learners the citizenship skills needed for issue remediation as well as the time needed for the application of these skills; and
6. provide an instructional setting that increases learners' expectancy of reinforcement for acting in responsible ways, i.e., attempt to develop an internal locus of control in learners. (p. 14)

A technique to be employed which may foster the development of empowerment is teaching environmental education through the local environment. The local issues focused on should include those which establish man as part of nature or the ecosystem. (Schaefer, 1992) Two main reasons why environmental education should focus on local issues are 1) urban/city living can be stressed and 2) it shows students they have the power to bring about change. (Schaefer, 1992) Seventy-four percent of the population lives in cities. (Schaefer, 1992) For them, the environment is the city and students need to learn how they impact it. When dealing with local environmental issues, students become empowered by learning they can initiate change by controlling the design of the community, changing their urban lifestyles, and influencing local government directly through councils and committees. (Schaefer, 1992) Schaefer suggests the following problems with only a global focus of environmental education: it doesn't promote individual action, individual actions aren't perceived as worthwhile, nobody wants to be the leader in taking on responsibility, it diverts attention away from local issues making them seem unimportant and unvaluable. Not only to spark interest but also to teach students that they do have the ability to make a difference, teachers may need to do some research of their own to uncover

a local environmental issue in their community, such as wetland protection, and teach environmental education through that specific local issue.

The Gullet Program in Austin, Texas is an elementary school filled with animals such as snakes, iguanas, rabbits, lizards, turtles, and bats. Everyday, two children from each class are assigned to clean, feed, and water the animals. The teachers rotate the responsibility of overseeing the children's routines. By the end of the year, both children and teachers know a lot about animal care. (Estes, 1993) Estes (1993) views this as a type of localized issue which promotes environmental sensitivity, considered to be an important predictor of environmental responsible behavior, and positive attitudes toward the natural environment. It is also an example of how professional educators can incorporate Hungerford and Volk's variables of personal investment, ownership, and internalized locus of control into the reality of school learning. (Estes, 1993)

The challenge that now exists is actually using the tools and strategies known to change learner behavior. Because some of the strategies may be non-traditional, educators may not implement them simply because they are different from past practice. (Hungerford and Volk, 1990) Bybee (1991) refers to today's environmental problems as a "planetary crisis." (p. 146) He also believes that in order to change students' behavior toward stewardship and conservation, educators must change the way they think and act first.

Bybee challenges the science educator to pave the way for reform in environmental education. Foremost, the educator must show leadership and accept responsibility for change. Through her profession, she can do this by using the current curriculum to teach about environmental issues. She must be sure to teach underlying concepts, i.e., managing the commons, such as groundwater. Lastly, she must encourage ethical reflection and critical thinking because this leads to citizenship. Teachers can accomplish these goals by addressing in the curriculum such issues as: knowledge of basic human needs, taking care of and improving the natural environment, conserving and wisely using natural resources, and creating community. (Bybee, 1991) If the integration of these issues is done effectively enough, students will come away with a sense of duty to themselves, others and the natural world. (Bybee, 1991)

Curriculum planners may employ one of the following four methods for promoting environmentally responsible behavior especially in the area of conservation: direct contact, modeling, information and exposure. (Newhouse, 1990) The direct contact method is by far the most preferable for instilling positive environmental attitudes, which Newhouse describes as one of the most influential factors affecting environmental behavior. Through a direct experience with the natural world, a person can focus on his own attitude, with attitude being the basis for behavior. Plenty of information should be provided, because more information leads to a more accurate attitude toward a particular topic. Direct experience also provides the opportunity for repetition or mental rehearsal which makes the attitude easily remembered. (Newhouse, 1990) If a person has an attitude based on false information, direct contact will likely cause a change in that attitude. Though essential, information when used as a method of changing behavior must be linked to old information and values. (Newhouse, 1990) Modeling may be a successfully implemented strategy for changing attitude. Modeling involves associating objects with people who are liked and respected. In order for it to work, the rewards for the person must be the same as for the modeler, the benefits must outweigh the costs, and the subject must be viewed emotionally, in a positive light. (Newhouse, 1990) Critics of the modeling method find the limitations to be that modeling is persuading people, not educating them, the learner is manipulated not taught, and it doesn't teach the skills needed to make future decisions.
(Newhouse, 1990) Whichever method is decided upon, the curriculum must be geared to the appropriate level of knowledge, attitude and moral development of the learner. Information is key, and action strategies must be taught to the learners. (Newhouse, 1990)

When it comes down to it, curriculums will be written in the style and form that the writer is most familiar with. There exist three basic models of environmental education curriculums. They are the empirical-analytical, the interpretative, and the critical. If the main goal of the curriculum guide is simply to impart knowledge of environmental issues, then the empirical-analytical style is fine. If, however, the goal is for the students to come up with their own interpretations and make moral decisions based on their interpretations, alternative, more innovative curriculums are needed such as the interpretative or critical.

(Stevenson, 1993)

The empirical-analytical method is appropriate for uncovering facts about environmental issues. This format is probably very familiar to most educators. A textbook, or some other published print media, decides the content and objectives to be learned by the students, how the teacher should teach it and how the students should be evaluated. (Stevenson, 1993) It may follow the typical classroom scenario of lecture, note-taking, test. Aside from the obvious problems of this type of presentation being boring and passive on the part of the students, it also doesn't provide answers to the values aspect of environmental issues, and it doesn't involve teachers in the creation or changing of curriculum. (Stevenson, 1993)

In the interpretative form of environmental education curriculum, the curriculum unfolds as the class progresses in its interactions with each other, the teacher and the materials. The learners themselves produce and verify their own meaning of a subject. (Stevenson, 1993) The limitation of the interpretative curriculum is that "no framework for conceptualizing moral or values questions and no moral vision of educational action or curriculum change exist, – crucial omissions from a curriculum framework for environmental education." (Stevenson, 1993, p. 7)

The critical curriculum model requires the teacher to direct her attention to her students' moral and ethical goals and the consequences of their actions. This is a somewhat individualized approach to environmental education, usually quite impossible in practice considering that most teachers are responsible for and need to reach a large number of students in a short period of time. (Stevenson, 1993)

Though both the interpretative and critical curriculum models have their faults, they also can have a very positive effect on environmental education. For one, teachers will have a better understanding of their own theories and values regarding the environment; once developed, they can incorporate them into the curriculum. Second, students actively construct environmental understanding and values, rather than passively absorb, at best, from someone else. (Stevenson, 1993)

As discussed previously, treatment of the affective domain is extremely crucial in

environmental education if changing behavior is the key goal. Iozzi has nine main recommendations for teachers of environmental education in the area of affective growth. The first is a way to teach environmental education that most experts agree on, by infusion in the existing school curriculum. Iozzi (1989) suggests really branching out into other subject areas rather than the traditional environmentally appropriate subjects like science or social studies. Teachers could use books in language arts or reading with environmental themes. Students could write poems about the natural environment as well as do art and music activities related to the environment. (Iozzi, 1989) Because attitudes are formed early in life, the most emphasis on these activities and the affective domain should be in elementary school. (Iozzi, 1989)

Teachers can use values clarification to help students understand and improve their environmental attitudes. The steps which need to be addressed are: understanding of one's own value system, analysis of how attitude affects behavior and how behavior affects environment, deciding which behaviors need to be changed and then finally, action or implementing the new behavior. (Iozzi, 1989)

Teachers need to help students develop moral maturity because environmental issues are often moral ones. Educators can teach their pupils to reason by using dilemma/scenario discussion activities. (Iozzi, 1989) Iozzi suggests going outside whenever possible, on walking tours, field trips or even resident camping experiences if possible. While all students benefit from similar types of environmental education learning experiences regardless of their backgrounds, teachers should keep in mind the needs of minority students. Educators can stress that environmental problems are social problems. This is everyone's world and everyone has an important role to play in solving its problems. (Iozzi, 1989)

There is no one teaching method that is best for developing the affective domain. But since different students have different learning styles, Iozzi advises using a variety of teaching techniques to reach everyone affectively. Inquiry methods with direct involvement are very good. Also, the case study approach, investigating a real environmental issue, helps develop good decision-making skills. At the proper level for the students involved,

questioning is essential. Educators should use simulations, creative drama and role playing in the classroom. Equally important is planning appropriate, varied activities for children, listening to students and allowing students to listen to each other. (Iozzi, 1989)

Because research has shown that the media can greatly influence positive environmental attitudes, and the fact that eighty-eight percent of our knowledge is acquired through sight and sound, Iozzi urges teachers to use TV, video, computers, films, audio tapes and periodicals in the classroom. Although teachers should be cautioned to look for bias in preprinted, free environmental education materials, if they appear to be free of bias, use them. (Iozzi, 1989) Finally, Iozzi encourages educators themselves to get involved in environmental activities and organizations.

In general , Engleson and Yockers list several characteristics of an ideal environmental education plan. The ideal environmental education curriculum must be learner focused. It should take into account the known developmental characteristics of learners. It should be holistic, universally oriented in contrast to Schaefer's assertion that environmental education should be taught through local environmental issues. It should demonstrate a concern for future generations. It should be issue and action oriented. As Iozzi, Simmons and Burdick propose, it should be continuous through all grade levels and all subject disciplines. Most importantly, it should be experientially oriented, for as Noel McInnus states, "the first law of environmental education: an experience is worth one thousand pictures." (Engleson & Yockers, 1994, p. 119) Following is a summary of suggested strategies for developing the subgoals of environmental education, knowledge, environmental ethic, and citizen action skills; the three subgoals that should be emphasized in an environmental enrichment unit curriculum guide for eighth graders.

Engleson and Yockers have classified learning experiences on a continuum from the most concrete, most active and most sensory to the most abstract, least sensory and most passive. Direct experiences allow students to use all of their senses; they are the most concrete and the most learner active experiences a child can have. Estes (1993) points out another positive aspect of using direct experience is that it is necessary for environmental sensitivity to blossom. A definite step in the right direction toward an environmentally

responsible citizenry would be environmentally sensitive teachers, serving as role models, leading students in direct experiences with the natural world. (Estes, 1993) While Newhouse (1990) also supports direct contact learning experiences as one of the most important for environmental education, she sees the most beneficial use of direct experience as forming or changing attitudes, not for construction of knowledge. Contrived experiences are almost as good. They reduce the size or take out a certain aspect of a subject to make it easier to understand. For example, studying erosion from a stream table in the classroom is a contrived experience. Dramatizations, demonstrations, computer simulations, displays, exhibits and models, videos, and radio fit somewhere in the middle between the most concrete educational experiences and the most abstract educational experiences. The author would assume that Iozzi would place TV, videos, and audiovisual technique somewhat higher up on the list since most knowledge acquired is through the visual and hearing senses. Visual symbols, using the chalkboard or overhead projector to present information or verbal symbols, and lecturing, are the most widely used and also the most abstract educational experiences available. Although learning can take place for older students by way of these abstract experiences, they shouldn't be used for the sake of finishing the textbook. (Engleson & Yockers, 1994) The construction of knowledge, i.e., concept formation begins with observations. Teachers must get students directly involved with making observations using all of their senses. To more fully develop the concept, students begin to use the tools of perceptual awareness such as classifying, sequencing, measuring, quantifying, inferring, predicting, etc. to process the knowledge and give it meaning. Educators must carefully plan what is to be learned, generate as many activities as possible to meet the learning styles of all involved and employ the direct experience as often as possible. (Engleson & Yockers, 1994)

In developing an environmental ethic in students, teachers should plan to use concrete experiences to form attitudes in younger children and change attitudes of older students while using more abstract experiences for forming attitudes in older children or changing attitudes of younger children. (Engleson & Yockers, 1994) Teaching strategies which can be used for value development are awareness activities, values clarification, values

analysis, social action or cognitive moral development strategies. Awareness activities involve introducing the students to the presence of something. Without naming it, the students must use their senses to describe it. Through a values clarification exercise, students make choices, affirm choices, and examine choices made repeatedly. Values clarification can be done by small/large group discussion, hypothetical and real life dilemmas, sensitivity and listening techniques, songs, artwork, games, journals, and interviews. The goal should be to have students thinking about how their choices and life style impact the environment. (Engleson & Yockers, 1994) Iozzi (1989) would agree with the use of values clarification in environmental education because he believes environmental education must reach not only the cognitive domain but the affective domain as well. Value analysis stresses logic and reason rather than emotion and feeling. Simple steps to follow in value analysis are: "1) identify the value question, 2) gather/organize facts about value question, 3) determine the validity of the facts, 4) determine the relationship of facts to the value question, 5) make the decision, 6) decide if the decision is acceptable." (Engleson & Yockers, 1994, p. 33) Social action is not very different from value analysis, but it is one of the most valuable learning experiences because it involves community learning. (Engleson and Yockers, 1994)

Cognitive moral development strategies give students experience and practice in making moral choices and discussing reasons for their choices. Teachers can use role playing or hypothetical dilemmas as cognitive moral development strategies. If a teacher sets up his own dilemma or role play he should consider the following guidelines: have a real choice, and a variety of alternatives, using real life problems, focus on the choice, and construct a focus question where there is a genuine conflict. (Engleson & Yockers, 1994)

The three main strategies which can be employed to develop citizen action skills are issue case study approach, group issue investigation, and individual issue investigation. All involve identifying, investigating and developing a plan for solving an environmental issue. (Engleson & Yockers, 1994) Although rather time consuming in the planning and implementing stages, it is multidisciplinary, so teachers could involve teachers from other subject areas to lighten the load. Hungerford and Volk (1990) would highly recommend the

issue investigation model over the case study model. For one, students would get to pick the issue investigated, rather than the teacher, as is done usually in the case study approach. Second, research indicates students will acquire more detailed information about an array of topics; they will have a greater sense of ownership and feel more empowered to act on issues through issue investigation techniques than by case study models. Last, teachers will most likely observe more outside school involvement from students involved in issue investigation than in case study. (Hungerford & Volk, 1990) The author speculates Hungerford and Volk would undoubtedly prefer the individual issue investigation to the group issue investigation. However, considering the typical amount of material to be covered in a school year and knowing that the typical issue investigation, if done properly, could take up to eighteen weeks (more than one marking period!), she would choose group issue investigation or even a case study approach, since valuable skills can still be learned, for practical purposes. Group issue investigation is probably the most appropriate method for middle/intermediate school children, according to the Guide to Curriculum Planning in Environmental Education. Actions that could be taken are letter writing, boycotting, conservation, monetary support to organizations, or planting trees. More mature students could probably handle individual issue investigations. The skills to be emphasized at the middle school level are investigation and resolution skills. This sample procedure could be used for leading students in a group issue investigation:

1. identify and clearly state environmental issue
2. identify participators and positions
3. evaluate solutions
4. gather more information from secondary sources (such as experts)
5. gather more information from primary sources (those directly affected)
6. interpret data
7. develop action plan
8. implement and evaluate action plan (Engleson & Yockers, 1994, p.133)

In the end, whatever strategies are implemented for teaching environmental education, the teacher or curriculum planner must consider the developmental, both cognitive and moral, level of the students. Curriculum planners also must consider the background experiences of students and long standing values and attitudes students bring with them into the classroom. Getting students to a point of wanting to take positive environmental

action is a very ambitious goal to say the least. If curriculum planners are to be successful, much research, planning and knowledge about the students is first necessary before the actual writing takes place.

III. Review of Similar Projects

What follows is a summary and critique of existing environmental education enrichment or supplemental units reviewed and research dealing with water education programs specifically. Where possible, curriculum planners should review the work of others in the field to generate ideas, modify stellar programs to suit the needs of the current curriculum plan, or just decide what is definitely not needed or wanted in their own particular curriculum guides.

Research shows that water education programs, the focus of this thesis, are effective in developing knowledge and also imparting positive attitudes toward water conservation as well as a permanent water ethic leading to good water use habits as adults. (Beiswenger et al , 1991) Water education programs are essential because "water is an important factor in the social and economic growth of any community and the state itself." (Brosz & Jacobs in Beiswenger et al, 1991, p. 25) Coastal states have had a head start in developing water education programs, but initially concentrated solely on marine environments. Only recently, have the needs of those living near freshwater been considered and programs developed designed to fit their particular needs. (Beiswenger et al, 1991)

The topics usually covered in water education programs include: water supply and distribution, water law and management, the uses and economic value of water and aquatic ecology and environmental values associated with it. Results of 450 completed surveys done by Beiswenger et al indicate that teachers report they have the most knowledge about the water cycle and the least knowledge about water laws. Therefore, generally high priority is given to the water cycle in their curriculums while low priority is given to water laws. (Beiswenger et al, 1991) A study done by researchers at an environmental immersion school found similar results. If teachers did not feel comfortable with their own knowledge base of a particular environmental issue, it would not be given high priority in

their curriculum. (Samuel, 1993)

Sixty percent of the teachers surveyed by Beiswenger et al (1991) would be willing to infuse water topics into their curriculum provided that they were given predeveloped materials to use, including hands-on activities, software specific to grade level, and they received plenty of inservice training. Results of research by Samuel (1993) and Lane et al (1994) concur with Beiswenger's conclusions. Telling teachers to teach environmental education or even handing them a curriculum is not enough, teachers must have the necessary inservice training to be able to develop their own knowledge base, values and attitudes about environmental issues before trying to implement it in the classroom.

Ed Willis, a facilitator of Project Wild, claims that it is not too late at the intermediate level to get school children excited and motivated about the natural environment. (Estes, 1993) Two well-known, nationally available programs for doing this are of course, Project Wild and GEMS. Project Wild has been available to teachers since 1983. It consists of interdisciplinary lessons designed to promote awareness of wildlife, nature and ecological systems, conservation, cultural and social interactions with wildlife and ultimately, responsible human action. (Estes, 1993) GEMS, Great Explorations in Math and Science, provides videos, activity modules, computer software and guides for teachers of math and science for infusing environmental education into their existing curriculums. (Estes, 1993)

Patricia M. Vito (1983) wrote, An Interdisciplinary Curriculum Guide in Environmental Education to Supplement and Enrich the Holt Earth Science Text. The goal of this curriculum guide is that after completing the activities, the students will gain enough environmental knowledge and concern to have a positive effect on the environment. (Vito, 1983) The guide was developed to be used interdisciplinarily, to include both indoor and outdoor activities, to match the text topics, and to depend on the student's abilities to interact, research, and think creatively. (Vito, 1983) The guide is also meant to be localized; to make use of the community's land, resources, and people. (Vito, 1983) The curriculum guide is structured in the following manner: it contains objectives, generalizations, strategy, lesson outline suggestions and activities for each unit, materials list, evaluation procedures and a bibliography. The enrichment activities in this guide

pertaining to water have to do with water pollution, the hydrologic cycle, and water conservation. Although the guide contains hands-on activities, creating an invention to conserve water or testing drinking water for phosphorus, chlorine, and nitrogen, it lacks attention to the affective domain, an area Iozzi (1989) deemed critical for a comprehensive environmental education program.

The Story of Drinking Water was published by the American Water Works Association to demonstrate the need for a good, clean water supply. (Bock, 1984) The guide was developed for use in science or social studies class. Iozzi (1989) favors branching out into other subject areas with environmental education rather than just the usual science or social studies. The author states that it is relevant for children because it involves them in problem solving and the use of their imagination. (Bock, 1984) Each activity contains objectives, though not stated behaviorally, teacher notes, reproducible student sheets, and added attractions. After a few introductory lessons on the nature of water, the premise of the activity book becomes that the town has run out of water. Students then role play several situations such as, where will they get their water from, how will they get it and how will they clean it.

While the colorful, cartoon-like format of The Story of Drinking Water may seem superficially appealing to some, deeper investigation of the book uncovers some inherent problems with this book as an environmental education tool. There is too much emphasis on water quality and supply in developing countries. The author agrees with Schaefer (1992) that teaching environmental education through the local environment can be just the thing to give students ownership of the situation and empowerment; they get to see the results of their work so they know they have the power to cause change. The objectives are not stated behaviorally. For example, one of the first lesson's objectives is to "provide background information about the nature of water." (Bock, 1984, p. 3) What is the observable outcome the teacher will evaluate at the end of the lesson? At times, the objective stated does not match the activity given. In other words, it doesn't seem possible that the students will reach the objective by performing the activity listed. For example, the objective of lesson nine, is to "make students aware of government water regulations," yet

the activity requires students to calculate the amount of water the community needs for one year and how much it would cost. (Bock, 1984, p. 19) There doesn't seem to be any connection between the activity and understanding that government regulations are there to protect the public. Finally, one of the purposes of the guide, forcing students to think creatively and to use problem-solving skills, is contradictory to the "activities" provided in the lessons. At least four lessons do not even require mental involvement on the part of the student because they are simply fact sheets. This curriculum guide would win the author's prize for how not to design a curriculum guide.

Another specific curriculum reviewed is My World, My Water and Me. The educational objective of this guide is to make students aware of the waste water pollution problem. The philosophy behind this educational goal is that New Jersey is the most densely populated state. Its inhabitants use 64 gallons of water per person per day. That number increases to 200-250 gallons per day when industrial and commercial uses are taken into account. Every water use results in pollution, therefore public education is vital. Every individual must realize, "pollution begins and ends with me." (Authorities Association of NJ, 1987)

The components of the guides are as follows: a story outline, background information for teachers, multidisciplinary activities, and a resource guide. The purpose of the story outline is to provide a thematic link for all concepts in the unit and requires students to use imagination. It can also be used for evaluation at the end of the program to sum everything up. The objective of the story outline requires the students to create an original vehicle that will be used on an imaginary trip from the drain pipe to the water treatment plant. (Authorities Association of NJ, 1987) The story outline goes on to cover such topics as: importance of water in our lives, what pollution is and where it comes from, the processing of water at the treatment plant, the difference between storm and sanitary sewers and specific water pollution problems in their town. (Authorities Association of NJ, 1987) This is where the problem begins, as the author sees it.

Using the story outline, the teacher is supposed to choose from a list of activities. The problem is there is no correlation between the topics in the story outline and the activities

section of the book. The author was quite confused and began looking for directions, "how to use this book" -- unfortunately, none were to be found. Sample activities include: brainstorm and classify water vocabulary and brainstorm songs with a water theme. An activity called, "Use Your Imagination" directed students to develop a solution to a water problem. The teacher was directed to "distribute an ice cube or ice chunk to each group saying, 'this is pure water, go for it.'" (Authorities Association of NJ, 1987, p.20) The teacher is not to give any further directions or mention what the goal is, the students are supposed to figure it out. The author has not figured out what goal the students are supposed to be trying to reach. In another hands-on activity, students must test for for impurities in water runoff samples using pH paper. There is never any discussion throughout the lesson as to why pH paper is being used and what it is supposed to indicate about pollution and impurities in water. Finally, the problem with the activities is that sometimes it seems as if steps have just been left out of the directions. In "Dissolved in Tears" (p. 19) students will make models of tear drops by filling plastic lunchbags with water and hanging them from the ceiling. Students must then infer how to produce the tears. The author imagines that without directions, many teachers would be worried that students would create more of a rainstorm in their classroom than tear drops. What the author dislikes the most about this program for use in the classroom is that it provides no follow up work or activity by the students once they've finished with the procedures. There is nothing provided to hold them responsible for their learning. If that is the case, how can they be held responsible for positive environmental action? Although there is an excellent background information section for teachers, behavioral objectives, and some hands-on activities, of the curriculums reviewed, the author would be least inclined to use this one because of its lack of organization and directions making it very teacher unfriendly.

Quite interestingly, the author found a curriculum on ocean pollution written by Louis A. Iozzi. While it would have been very revealing to compare his curriculum to his nine recommendations for implementing environmental education programs, it would be inappropriate to do so as the curriculum was written several years before the article on the affective domain in environmental education. However, since he does make mention of the

importance of the affective domain in his curriculum guide, some amount of comparison will be made. The curriculum, If Fish Could Talk, came about because of the controversy over ocean dumping. Some believe it doesn't matter what is dumped in the ocean because the ocean has the ability to purify itself, while others think it is important to uncover the true effects of dumping wastes into the ocean. (Iozzi, 1984) The major goal of the program is to increase knowledge about ocean pollution, especially in the New York - New Jersey coastal zone. Iozzi's hope is that after completing the program, students will show interest in helping to solve problems related to coastal pollution. (Iozzi, 1984)

If Fish Could Talk is a multimedia, activity oriented program. Originally developed for secondary school, it can easily be adapted for both younger and older students. It consists of two units: Sources of Pollution in New York/New Jersey and Effects of Pollution in New York/New Jersey. Each unit contains a filmstrip, cassette recording, pre/post tests, key ideas (to be xeroxed and given to students), discussion questions/activities, student readings and teaching suggestions. The second unit includes a game board which can be played to reinforce the basic concepts of marine ecology. The treatment of the cognitive domain is through the key ideas section; the treatment of the affective domain is through the discussion questions/activities. These discussion/activities are open ended; they require students to apply information they've learned to a new situation in order to solve a problem. Often the decisions which must be made to solve the problem involve attitudes, values and beliefs, and ask students to look at a different viewpoint than science, such as the social, political or economic aspect of the issue. (Iozzi, 1984) It is interesting to note that Iozzi, best known to many for his work relating to the affective domain and environmental education, has produced an environmental education curriculum guide in which the main emphasis is on knowledge and the cognitive domain.

The description of the activity oriented program might lead some teachers to believe that students will be performing a lot of activities. Actually the activities have more to do with working in groups debating various sides of the issues. The role play method is used often throughout the program, which is a useful tool to develop a student's affective side. By putting herself in someone else's place, a student gets to experience that person's feelings

and attitudes. One problem the author sees with this program is that it is dated. A teacher could not use the filmstrips or articles today because they are too outdated. Another problem is there are no behavioral objectives. Objectives are stated as, "make students more knowledgeable, provide students with a basic understanding, increase student ability to develop and present arguments." (p. 8) Finally only progress in the cognitive domain is evaluated because the pre/post test measures just the amount of knowledge gained. In its day, this program was probably a valuable tool in environmental education, however it could not be used today without some serious modification and modernization.

Two of the more impressive works the author reviewed include Clean Water Works and the 4Rs Project. Clean Water Works was developed for the teachers in Gloucester County. According to Rick Westergaard of the County Planning department, after doing work with the USGS to identify Critical Area #2, it became apparent the public needed to be educated on water issues. This project became part of the watershed management plan. A group of hydrology specialists and teachers came together to create a curriculum guide on water issues to supplement the existing K-12 science curriculum. The group determined that lecture/demonstration methods are inadequate because there is no student involvement. Rather, a variety of teaching methods as Iozzi suggests, could be employed to learn about water, such as simulations, field trips, games, and labs. (Clean Water Works, 1992) They decided to promote learner involvement through questioning. (Clean Water Works, 1992) Each activity provides a way to find an answer to a question dealing with water issues. By challenging students to find their own answer, it emphasizes creative thinking and problem solving skills. (Clean Water Works, 1992) Each activity provides, for the teacher, background information, step by step procedures, extensions, references, and audio-visuals. The guide was written for teachers on the environmental aspects of water. The author finds this program preferable to the others because she feels that it helps to develop the ownership variable proposed by Hungerford &Volk as extremely important for changing behavior. The lessons are labeled "interest inquiries." Students pick which issues are interesting to them and ask questions to find a solution. The questions they ask lead them to planning an experiment or some other type of activity to solve the problem. It

is a kind of scaled down version of the issue investigation model promoted by Hungerford & Volk and Engleson & Yockers. This type of issue investigation is much more manageable time wise in the regular school curriculum.

Each Floridian manufactures seven pounds of garbage per day. (LaHart, 1990) As the population grows, waste disposal will be an even bigger problem. Education is the key and educational programs may help reach the mandated 30% reduction in volume of solid waste by 1994. (LaHart, 1990) This need for waste disposal reduction led to the creation of the 4Rs Project - A Solid Waste Management Curriculum for Florida Schools. The purpose of the program is to assist teachers in teaching in such a way that students will contribute to solving problems. The guide is designed to promote awareness, knowledge, and responsible action. The materials can be infused into existing curricula and it also attempts to help students attain the Minimum Student Performance Standards required by Florida schools. (LaHart, 1990)

Each lesson yields a plethora of information. This is what the author finds so appealing about this program. It is very teacher friendly. Everything is there that the teacher needs to implement the lesson. There is no guesswork involved. Each lesson contains a sidebar describing the appropriate grade level of activity, subjects the activity relates to, skills the activity will develop, group size requirements, the appropriate setting, the Florida Department of Education performance standards correlating to the activity, the 4Rs framework matrix, vocabulary and time needed to complete activity.

Each lesson follows the same structural design. Objectives are listed behaviorally and all three domains are engaged, cognitive, affective and psychomotor. A summary of the method used is provided. Background information, materials needed, and step by step procedures including key questions are described. Suggestions for evaluation are provided within the framework of the lesson. Extension activities are provided for interested teachers or students. The most unique feature of this curriculum guide is the last section called Action. The section lists specific actions students can take relating to the environmental problem or issue in the lesson. The author finds this to be a most important thing to do for younger students who have the positive attitude but are not exactly sure

what to do with it. This program gives students actual options for getting involved and acting in an environmentally responsible way.

Another feature which makes this program quite effective to use is the 4Rs Conceptual Framework and Matrix. The framework lists all the major concepts in preK-12 curriculum which "lead students through four levels of awareness, attitudes, skills, and behavior" (LaHart, 1990, p. xii) The matrix then identifies which lesson correlates with which framework concept. This system provides a way to make sure that material is not needlessly repeated over and over again throughout the different grade levels.

With NJDEP's mandate to reduce reliance on the PRM aquifer, water quality and conservation issues are very pertinent to the residents of Glassboro right now. As suggested by Bybee, the author will attempt to take a leadership role at this time, by changing the current Eighth Grade Science Curriculum with a supplemental enrichment unit on local water resources and water conservation practices. Some of the critical educational components developed by Hungerford & Volk and Engleson & Yockers must be employed in the curriculum guide if the goal is to lead students to environmental citizenry and not just knowledge.

CHAPTER THREE

Methodology

The purpose of this project is to develop a series of enrichment activities dealing with local water resources and water conservation practices to supplement the existing Glassboro Eighth Grade Science curriculum. In coming to this decision, the author solicited the help of the Mayor of Glassboro, Todd Armstrong, a teacher at the school where the author works, and the Glassboro Environmental Commission. With the Mayor and the Commission, discussion ensued to find a place within the Eighth Grade Science curriculum for recent topics relevant to Glassboro. The water issue, it was decided, fulfilled both of these requirements.

I. Sources of Data for Background Information

The next step in preparation of this project was for the author to learn as much as she possibly could about the local water resources and issues. The author engaged in three activities to accomplish that goal. First, the author held personal interviews, over the phone as well as face to face, with John Manganaro, Superintendent of the Glassboro Water and Sewer Department, and Rick Westergaard, of the Gloucester County Planning Department. Both gentlemen shared valuable information with the author and answered pertinent questions. Second, the author attended the ANJEC forum at the New Jersey State Aquarium titled, "Water, Water Everywhere and Not a Drop to Drink: The Crisis of Our Waters,"as well as a regional meeting of the newly formed South Jersey Safe Drinking Water Committee. Various lecturers spoke at both meetings to further develop the author's knowledge of local water resources. Third, the author collected a variety of publications from the interviews and the meetings, including government publications from the US Department of the Interior and the USGS, State reports, Water for the 21st Century, A Vital Resource, and local documents including recent results of local water testing and the Clean Water Works Watershed Management Plan. These references will be used primarily to comprise the background information section of the enrichment activities.

II. Criteria for Lesson Selection

With the mass of data gathered during the preliminary research, ranging from the simple to the rather complex, the author needed to decide which content would make it into the lessons and which would not. Several criteria were used for selecting the lesson topics, the most important being the content most appropriate for the average eighth grade skill level. Consideration was also given to the likeliness of the material being easily integrated into the Geology section of the Merrill Earth Science text book, specifically the Water Systems unit which typically is allowed about three to four weeks in the marking period. Location of the school and budgetary constraints also factored into the lesson topic selection. Field trips in the upper grades requiring bus transportation are an unlikely event so any lessons done outside of the classroom must be within walking distance. With a minimal, at best, budget to work with, lessons must incorporate only materials which can be obtained easily and inexpensively. The last criteria for lesson topic selection was that topics must be picked in which it was easy to develop lessons that centered around critical thinking, problem solving and cooperative learning. The author has routinely used these strategies in the past and students would be most familiar with them.

III. Method of Gathering Data

Armed with the necessary knowledge regarding the content of the lessons, the author then proceeded to review the current related literature pertaining to environmental education programs. The author went about locating this information by employing the CD ROM at Rowan Library and at the South Jersey Environmental Information Center at the West Deptford Public Library. While the author found a multitude of information on environmental education, two publications in particular provided a wealth of data on the subject. These were The Journal of Environmental Education and A Guide to Curriculum Planning in Environmental Education from the Wisconsin Department of Public Instruction.

IV. Lesson Design

The last step in preparing to complete this project was to decide on a lesson format for the enrichment activities. This was achieved by reviewing several published programs. The sources for the published programs were the Glassboro Water and Sewer Department, The Gloucester County Planning Department and the office of Gloucester County Environmental Education Specialist, Anne Seebold, as well as theses related to the topic from Rowan College of New Jersey Library. John Manganaro of the Glassboro Water and Sewer Department provided the author access to The Story of Drinking Water, 1984 and My World, My Water and Me, 1987. Rick Westergaard, of the Gloucester County Planning Department, gave the author a copy of the county's program, Clean Water Works, 1992. Anne Seebold, Gloucester County's Environmental Education Specialist, provided the author with If Fish Could Talk, 1984, and 4Rs Project - Solid Waste Management Curriculum for Florida Schools, 1990. Two theses from Rowan College used were An Interdisciplinary Curriculum Guide in Environmental Education to Supplement and Enrich the Holt Earth Science Text, 1983 and A Series of Environmental Activities to Supplement the MacMillan Earth Science Text, 1994.

After reviewing all of these resources, the author modeled her lesson format on the Florida curriculum because of its attention to detail and teacher friendliness. The lesson design format follows.

Lesson Recommendations:
Grade:
Subject:
Skills:
Merrill Correlation:
Setting:
NJ Core Content Standard Correlation:
Vocabulary:
Time Allotment:

LESSON FORMAT:
OBJECTIVES: behaviorally stated
METHOD: briefly describes how students will achieve objectives
BACKGROUND INFORMATION: for teacher
MATERIALS NEEDED: for teacher and student
PROCEDURE: for students
EVALUATION: suggestions for evaluating lesson
WHAT YOU CAN DO TO MAKE A DIFFERENCE: suggestions for students to become actively involved
STUDENT HANDOUTS OR TRANSPARENCIES

V. Background of the Researcher

1. Graduate of Temple University, Philadelphia, Pennsylvania with a B.S. in Secondary Science Education, specializing in the Biological Sciences.

2. Hold New Jersey Comprehensive Certification for grades 7-12.

3. Matriculated graduate student at Rowan College of New Jersey in Environmental Education and Conservation.

4. Five years teaching experience in Earth Science for Grade 8.

5. Two years with CHAMP program developing lessons with environmental themes and utilizing the outside environment.

6. Received the New Jersey Governor's Teacher Recognition Award 1993.

7. Serve on District Science Curriculum Committee.

8. Member of New Jersey Earth Science Teachers Association

9. Vice Chairperson of the Glassboro Environmental Commission.

10. Member of the South Jersey Regional Safe Drinking Water Committee.

11. Coordinated school wide Environmental Education activities in celebration of Earth Day, 1995.

12. Organized and coordinated annual school wide as well as community participation in Gloucester County Clean Communities Program.

CHAPTER FOUR

Presentation of Enrichment Unit

The purpose of this study is to prepare a series of enrichment activities dealing with local water resources and water conservation practices to supplement the existing Glassboro Eighth Grade Science Curriculum. This chapter is organized into lesson plans following the lesson design format outlined in Chapter Three of this thesis and on the following page. Any student handouts will immediately follow the accompanying lesson. This unit is specifically designed to supplement the Water Systems Subunit of the Geology Unit of the eighth grade science book, Merrill Earth Science. Users may select from the array of lessons to tailor to their own specific needs or use the entire supplemental unit to enhance their Geology unit. It is the sincere hope of this author that through participation in this unit, students will gain knowledge about their local water system, acquire a positive attitude to want to conserve and protect it, attain the skills necessary to participate in positive environmental actions regarding the local water system and finally to maintain a lifestyle that promotes water conservation.

Lessons begin after a review of the lesson design format on the following page.

LESSON DESIGN TEMPLATE

Lesson Recommendations:

Grade:

Subject:

Skills:

Merrill Correlation:

Setting:

NJ Core Content Standard Correlations:

Vocabulary:

Time Allotment:

OBJECTIVES: The student will be able to:

METHOD:

BACKGROUND INFORMATION

MATERIALS NEEDED:

PROCEDURE:

EVALUATION:

MAKING A DIFFERENCE:

HOW WET IS PLANET EARTH?

Lesson Recommendations:

Grade: 8
Subject: Science, Math, Social Studies
Skills: comparing, calculating, measuring, interpreting, estimating
Merrill Correlation: Section 7-1
Setting: classroom
NJ Core Content Standard Correlations: 3, 4 ,4.1, 4.3, 4.6, 4.8, 4.10, 5.5, 5.10, 5.12, 6.9
Vocabulary: water cycle, freshwater, saltwater, groundwater
Time Allotment: one forty minute class period

OBJECTIVES: The student will be able to:
° Describe the amount and distribution of water on the Earth in oceans, rivers, lakes, groundwater, icecaps, and the atmosphere.
° Make inferences about the importance of responsible water use.

METHOD: Students calculate water volumes using percentages.

BACKGROUND INFORMATION Earth has been coined the water planet because roughly 75 percent is covered with water. The hydosphere is all of Earth's water sources which include oceans, rivers, lakes, ponds, groundwater, ice caps, and water in the atmosphere. Water is a renewable resource; it is recycled through the water cycle. Usually, people think of water as being limitless; however, scientists believe that the water we have on Earth right now is all the water we will ever have. The amount we have available to use depends on its quality. People must understand they have a responsibility to maintain the quality of the water, to protect and conserve it. This activity intends to show just how limited the amount of water available for our everyday use really is and to encourage students to think about the need for responsible water use. (WREEC, 1987)

MATERIALS NEEDED: One five gallon fish tank, calculators for each student, measuring cup for each group, large beaker for every group, one measuring tablespoon for every group.

PROCEDURE:

1. Introduce students to the percentages of water sources on Earth. Have them determine which are freshwater sources. Have them determine which freshwater sources are really available for our use. Ask them why we and other life forms need usable freshwater. Ask them what could reduce the usable percentage of existing freshwater.

2. Show them a fish tank filled with five gallons of water. Tell them this represents all the water in the world. Inform them they are going to calculate the amount of water in the tank that represents each water source.

3. Using the conversion factor 5 gallons = 1280 tablespoons, instruct them in how to change the percentages to tablespoon amounts. (For example: Oceans make up 97.2% of Earth's water so .972 X 1280 = 1244.16 tablespoons) Monitor student progress, provide assistance as needed.

4. When students have made all the calculations, have them determine in tablespoon amount how much freshwater is available to use. Have one student from each group extract that much from the tank with the tablespoon and large beaker.

5. Next have students determine how much freshwater is available to use without the icecaps. Have another student extract that amount from the large beaker to the measuring cup.

6. Looking at the amount of that resource, encourage small group discussion as to why it is so important and necessary to use water responsibly. Have a group recorder report results back to the class.

Predominant Source: *Project Wild Aquatic*, 1987

EVALUATION: Students should be able to estimate the percentage of water that is distributed in its various sources and answer the question, why is it important that humans use water responsibly?

MAKING A DIFFERENCE: Create a mural of the water cycle that graphically includes the statistics that represent the relative amount of water in each component of the cycle. Highlight the amounts of freshwater available to use. Ask to hang the mural in the school hallway to make others aware of responsible water use.

Name _____

HOW WET IS PLANET EARTH?

WATER ON EARTH	%
Oceans	97.2
All ice caps/glaciers	2.0
Groundwater	0.62
Freshwater lakes	0.009
Inland seas/salt lakes	0.008
Atmosphere	0.001
All rivers	0.0001

1. Place a check next to the sources of fresh water available for our use.
2. Estimate the % of fresh water available for us to use. _____
3. Why do humans need usable fresh water? What about other life forms?
4. What could reduce the usable % of existing fresh water?

CONVERSION WORKSHEET

Five gallons represents all the water that exists in the world. You are going to calculate the amount of water in the tank that represents each water source using the conversion factor, 5 gallons = 1,280 tablespoons. Listen as your teacher explains how to make the conversions. Then record work below.

Oceans	.972	X	1280	=	1244.16 tbsp
All ice cap/glaciers		X	1280	=	
Groundwater		X	1280	=	
Freshwater lakes		X	1280	=	
Inland seas/salt lakes		X	1280	=	
Atmosphere		X	1280	=	
All rivers		X	1280	=	

FOLLOW UP:

1. With group members, determine how much freshwater is available for us to use.
2. One student should go up to the tank and extract that much water with the tablespoon and large beaker.
3. Now determine how much freshwater is available without the ice caps.
4. Another student should extract that much from the large beaker to the measuring cup.
5. Look at the amount of that resource in the measuring cup, discuss with your group members why it is so important and necessary to use water responsibly.
6. Elect a group spokesperson who will be comfortable sharing your thoughts with the rest of the class.

PERFORMING A SERIAL DILUTION

Lesson Recommendations:

Grade: 8
Subject: Science, Math
Skills: analyzing data, measuring, following directions, comparing, inferring, observing
Merrill Correlation: Section 7-4
Setting: Classroom
NJ Core Content Standard Correlations: 2, 3, 4, 4.3, 4.6, 4.11, 5.2, 5.5
Vocabulary: concentration, dilution, parts per million, parts per billion
Time Allotment: one forty-minute class period.

OBJECTIVES: The student will be able to:
° Explain the meaning of concentration and dilution
° Differentiate between parts per million and parts per billion
° Identify observations and inferences
° Perform a serial dilution procedure

METHOD: Students mix food coloring dye with water to produce a serial dilution. Using this serial dilution students should be able to explain what parts per million and parts per billion refer to.

BACKGROUND INFORMATION Pollutants in groundwater are often measured and reported in parts per million and parts per billion. These numbers can be very difficult for students to comprehend. Begin several months ahead of this activity to collect local newspaper articles dealing with water pollution which use the terms ppm or ppb in the article. Introduce the concept of ppm with percent or parts per hundred. Tie in the saline solutions tested in Oceanography. Remind students that they tested 2 percent, 6 percent and 10 percent solutions of salt water. Ask them to explain what a 2 percent solution is. (2 grams of salt for every 100 grams of water.) Explain that the food coloring is a 10 percent solution and ask them what that means. Lead discussion to millions and billions, ask students which number is larger. Ask them again which is larger, one ppm or one ppb. Write the numbers on the chalkboard. Inform students you will return to these numbers after the activity. (Koker, 1991)

MATERIALS NEEDED: For students working in pairs: Chemplate or similar container, medicine dropper, paper towel, tap water, small cup for rinse, red food coloring, newspaper articles with reference to ppm or ppb, student handout sheet, pen or pencil.

PROCEDURE:

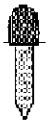
1. Read through all directions carefully before beginning.
2. Work on a white surface, such as a piece of paper to make your viewing easier.
3. Fill the large oval of the chemplate with water and fill the small cup with water.
4. After your teacher places 10 drops of red food coloring in your first cup, use the eyedropper to put one drop of it into cup 2. After rinsing the eyedropper completely in the small cup, add 9 drops of water to cup two. Mix well.
5. Continue in this fashion to fill the rest of the cups. Add one drop from the previous cup, rinse the eyedropper, then add 9 more drops of water to that cup. Mix well after the water has been added.
6. Record the color of each cup in the data chart and determine the concentration.
7. Complete the activity by answering the follow up questions on student sheet.

Predominant source: CEPUP module in *Science Scope*, 1991

EVALUATION: The teacher constructs a bar graph on the chalkboard indicating in which cup students first detected no color. Through questioning, the teacher leads students to identify the ppm and ppb concentrations of their experiments.

Name_____

PERFORMING A SERIAL DILUTION



PURPOSE: To perform a serial dilution and differentiate between parts per million and parts per billion.

MATERIALS: chemplate, eyedropper, piece of white paper, water, small cup or beaker, red food coloring, pen or pencil.

PROCEDURE:

1. Read through all directions carefully before beginning.
2. Work on a white surface, such as a piece of paper to make your viewing easier.
3. Fill the large oval of the chemplate with water and fill the small cup with water.
4. After your teacher places 10 drops of red food coloring in your first cup, use the eyedropper to put one drop of it into cup 2. After rinsing the eyedropper completely in the small cup, add 9 drops of water to cup two. Mix well.
5. Continue in this fashion to fill the rest of the cups. Add one drop from the previous cup, rinse the eyedropper, then add 9 more drops of water to that cup. Mix well after the water has been added.
6. Record the color of each cup in the data chart and determine the concentration.

DATA TABLE:

CUP #	COLOR	CONCENTRATION

FOLLOW UP: Answer the following questions in complete sentences on lined paper and attach it to this handout.

1. In which cup did you first detect no color? Was there really any food coloring in there? Why or why not?
2. What was the concentration of the first cup in which you detected no color? Explain how you found it.
3. What was the concentration of the last cup?
4. What is the difference between ppm and ppb?
5. Summarize how to perform a serial dilution.

GETTING A CHARGE OUT OF GROUNDWATER!

Lesson Recommendations:

Grade: 8
Subject: Science, Social Studies
Skills: comparing, observing, describing, identifying, concluding
Merrill Correlation: Section 7-3
Setting: classroom
NJ Core Content Standard Correlations: 2, 3, 4 , 5.1, 5.2, 5.10, 5.12, 6.9
Vocabulary: aquifer, groundwater, recharge, discharge, infiltration, permeability, water table
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
° Identify several sources of recharge for groundwater.
° Identify several sources of discharge for groundwater.
° Explain how water moves from recharge to discharge areas.
° Analyze the connection between surface water and groundwater.

METHOD: Students will build a model which they manipulate to include hills, a valley, a pond and groundwater. Students observe and discuss what happens to the system as they simulate rain and a well pumping water from the system.

BACKGROUND INFORMATION Glassboro's water needs, like many other municipalities in South Jersey, are served by groundwater, water in saturated zones beneath the Earth's surface. Rock materials in which groundwater flows easily or it can be pumped out for use are called aquifers. Glassboro will soon be getting more of its water from the Kirkwood - Cohansey aquifer which is an unconfined aquifer or water table aquifer. (Dooley, 1995) An unconfined aquifer is an aquifer in which the water surface or water table is able to rise and fall as water moves from recharge areas to discharge areas. Recharge adds water to the groundwater system. Recharge starts out as precipitation which falls into surface water and also infiltrates into the ground and percolates down to the water table. Surface water bodies such as rivers, streams and ponds can recharge aquifers when the water table is lower than the surface water body. Generally, recharge areas are higher in elevation than discharge areas. Discharge takes water away from the groundwater system. Discharge areas include places where groundwater is moving from the aquifer to a spring, seep, wetlands area, pond or stream. Discharge occurs when the water table is at or above the elevation of the discharge area. Because surface water and groundwater are connected, stream flow is maintained by groundwater seeping into the stream. The water surfaces of many ponds and wetlands are an extension of the local groundwater system. Groundwater can also be discharged by pumping from a well. (Vandas, 1993)

MATERIALS NEEDED: For each group of four: clear plastic storage container, enough gravel to fill container 2/3 full, two paper cups (the same size but one with holes punched in the bottom), one pump dispenser from softsoap or hand lotion containers, enough water to fill one paper cup, grease pencil, twigs or small tree branches, (for trees in model) science journal, pen or pencil.

PROCEDURE:

1. Obtain the clear box with gravel from your teacher. Push gravel to both sides of the container so that a valley is created in the center. Make sure a small amount of gravel remains in the bottom of the valley.
2. Arrange the twigs or branches on the hills to represent trees.
3. Fill the cup (*without holes*) with water. Simulate rain by pouring the water into the cup with holes over the hills. Record observations about where the water goes.
4. Use a grease pencil to mark where the water level is in the container.
5. Insert a pump into one of the hills and push it into the groundwater. Each person in the group should press the pump 20-30 times after the water has begun to flow. Allow this water to flow into the paper cup with no holes. Observe the level of the water after each student has taken a turn pumping.
6. Identify in your journal, which step represented recharge and which represented discharge. What happened to the pond when water was pumped out?

Predominant Source: *Science Scope*, 1993

EVALUATION: Have students respond to the following question in their journal using observations made during activity: What would happen to Mantua Creek if a well was drilled near that stream and enough water pumped out to lower the water table around the stream?

MAKING A DIFFERENCE: Take note of the recharge/ discharge areas near your home. Remember that surface waters are connected to groundwater, our drinking water. Encourage family members to dispose of motor oil or other hazardous household wastes in the proper manner.

AQUIFERS AND PERMEABILITY

Lesson Recommendations:

Grade: 8
Subject: Science, Language Arts
Skills: estimating, classifying, comparing, analyzing data, observing
Merrill Correlation: Section 7-3
Setting: classroom
NJ Core Content Standard Correlations: 3, 4, 3.3, 5.2, 5.10
Vocabulary: aquifer, permeable, impermeable
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
- Perform an experiment to test the rate of absorption of three different materials.
- Define permeable and impermeable.
- Evaluate the absorption rates to determine which material would make the best aquifer.

METHOD: Students test the absorption rate of three different materials by dripping water onto the material and observing the rate at which water is absorbed. Students conclude from their observations which one would make the best aquifer.

BACKGROUND INFORMATION: Groundwater is water that fills the empty spaces between rocks and cracks in rocks underneath the Earth's surface. An aquifer is a layer of permeable rock that has connecting pores and transmits water freely. Permeable rock describes rock that has numerous connecting pores which allow water to flow through it easily such as sand and gravel. Impermeable refers to rock that has very small pores and does not allow water to move through it easily. Examples are clay and shale. (Snyder, 1995) There are five major aquifers on the New Jersey Coastal Plain. They are: Potomac, Raritan, Magothy (PRM), the Englishtown, the Wenonah-Mt. Laurel, the 800 foot sand of the Kirkwood formation and the Kirkwood-Cohansey. (Vowinkel & Foster, 1981) Glassboro has historically received its water supply from the PRM, and the Wenonah-Mt. Laurel aquifers. In order to comply with the 1996 NJDEP mandate of reducing reliance on the PRM aquifer, Glassboro in the future will be pumping water from the Kirkwood-Cohansey aquifer to meet its water supply needs. (Dooley, 1995) The PRM is a confined aquifer made up of alternating layers of clay, sand, silt, and gravel. It is the largest and most productive aquifer but its levels have dropped due to overwithdrawal and it is experiencing problems with saltwater intrusion. (Vowinkel & Foster, 1981) The Kirkwood-Cohansey is an unconfined, shallow aquifer composed mostly of quartz sand, gravel, and silt with some clay layers.

In many areas where agricultural lands overlay it, inorganic chemicals associated with agricultural practices have been detected in the groundwater. (Kozanski, 1995)

MATERIALS NEEDED: Eyedropper, water, 3 clear plastic cups, jars or beakers, 250 ml each of sand, gravel, and clay, a cup for water, journal, pen or pencil.

PROCEDURE:

1. Fill one container with gravel, the second with sand and the third with clay.
2. Use the dropper and a small cup of water to place drops of water onto each material.
3. Record what happens to the water for each sample in your journal.
4. Note the rate at which each absorbed water in your journal.
5. In your journal, write a paragraph based on your observations, in which you determine the material that would make the best aquifer. In your paragraph define aquifer and be sure to use the terms permeable and impermeable to describe the materials tested in your experiment.

EVALUATION: Have students share journal entries with the class. Afterward, ask them the following question to assess their knowledge of permeable, impermeable. Shale is very impermeable rock made of clay. Sandstone is very permeable. Which of these two rocks would make the best aquifer? Explain.

MAKING A DIFFERENCE: Reduce your own reliance on the PRM and Kirkwood-Cohansey aquifers by not wasting cold water; instead recycle it. Use less water in the bathtub, don't use toilets to dispose of trash.

PROBING POROSITY

Lesson Recommendations:

Grade: 8
Subject: Science, Math
Skills: experimenting, calculating, comparing, analyzing data, observing
Merrill Correlation: Section 7-3
Setting: classroom
NJ Core Content Standard Correlations: 3, 4, 4.1, 4.5, 4.6, 4.9, 5.2, 5.5, 5.10
Vocabulary: aquifer, porosity
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
- Create an aquifer model and view how water is stored in the pore spaces of the materials that compose the aquifer model.
- Create two different aquifer models and compare porosities of the materials that compose the different aquifer models.
- Collect data in science journal for comparison of different porosities.

METHOD: Calculate porosity by pouring water from a 100 ml graduated cylinder until it reaches the top of a container filled with gravel and one filled with a mixture of gravel and sand. The students then compare the porosities of each to the other.

BACKGROUND INFORMATION Groundwater is stored underground in between spaces in rock materials. The ability of rock material to store water is called porosity. Porosity can be measured as a ratio of openings in the rock material to the total volume of rock material. Porosity depends on the range in size of the particles and the shape of the particles. Angular shaped particles will have a greater porosity because they will not pack as tightly together as round particles would. A uniform distribution of particle sizes will result in a greater porosity than mixed particle sizes because when the particles are of different sizes the smaller particles get packed into the spaces around the larger particles thereby reducing the space available to hold water. (Vandas, 1993)

MATERIALS NEEDED: For each group of 4: 100 ml graduated cylinder, two 266 ml clear plastic cups, dry pea size gravel for one cup, a 50-50 mixture of sand and pea size gravel for the other cup, water, journal, pen or pencil.

PROCEDURE:

1. Construct two aquifers by filling one cup with gravel and the other with a mixture of sand and gravel. Predict what will happen when you pour water into each aquifer. Then guess the amount of water, in ml, that each model will hold. Record this number in your journal.

2. Slowly pour water from a filled 100 ml cylinder into the gravel aquifer until the water level reaches the top of the rock materials. (Be careful not to splash the water as it is poured into the cup.) Calculate the amount of water poured into the gravel. Record in your journal.

3. Repeat #3 for the gravel and sand aquifer. Record results.

4. Calculate the porosity, (how much water rocks can store) of the materials in the two aquifers as percentages. (Divide the volume of water poured into the cup by the total volume of the cup, then multiply this quotient by 100.)

5. Compare the porosities of the materials.

Predominant Source: *Science Scope*, 1993

EVALUATION: Tally student data onto the chalkboard or overhead projector. Lead the class in a discussion of the following questions: Which model aquifer has the greatest porosity? What characteristics of the rock materials determine porosity? Does the size of materials affect porosity? Which model aquifer represents the location best suited for drilling a well?

MAKING A DIFFERENCE: Be informed of your aquifer system. Find out whom it serves, and what percentages are used industrially, commercially and domestically. Find out how your drinking water is managed and what your local government is doing to help protect it. Only informed citizens can take steps to help solve problems associated with groundwater.

WHAT IS THE EFFECT OF STREAM VELOCITY ON EROSION?

Lesson Recommendations:

Grade: 8
Subject: Science, Math, Language Arts
Skills: calculating, hypothesizing, analyzing data, observing, public speaking
Merrill Correlation: Section 7-1, 7-4
Setting: local stream
NJ Core Content Standard Correlations: 3, 4 ,3.1, 3.2, 4.1, 4.3, 4.4, 4.9, 5.2, 5.5, 5.12
Vocabulary: velocity, erosion
Time Allotment: one eighty-minute class period, arrangements must be made to double period

OBJECTIVES: The student will be able to:
° Measure a precise distance and time.
° Use the measurements to calculate velocity.
° Predict where stream will have most velocity.
° Brainstorm effects of increased erosion of stream over time.
° Develop a solution to the problem.

METHOD: Students will determine velocity of the stream at its center and edge by timing how long it takes a fishing bob to travel a certain distance. Students will predict where most erosion will take place, what effects it might have and what can be done about it. Their findings will be reported back to the class via oral report.

BACKGROUND INFORMATION Sediment entering waterways through erosion is a major water quality concern. The sediment may be rock particles or biological matter that eroded from land surfaces or streambanks. Once in the waterway, this sediment creates several problems. For one, navigation could be restricted. With an increased amount of sediment, there might be a decreased amount of water holding capacity and flooding could be more likely. The amount of light to aquatic plants could be lessened and affect the plant's ability to produce its own food. Sediments in the water could also clog animal gills. Breeding areas could be disrupted and bottom dwelling animals could be suffocated. Stream erosion is greatest where velocity is greatest. Erosion contol methods include catchment ponds, planting increased amounts of vegetation along banks and in agricultural areas, construction areas and mining areas. (Vandas, 1994)

MATERIALS NEEDED: Fishing bobs, calculators, measuring tape, stop watch or clock with second hand, science journal, pen or pencil.

PROCEDURE:

1. Use the measuring tape to mark out 10 meters along the stream bank.
2. Drop the fishing bob at the edge of the stream at the beginning of the 10 meter mark and time how long it takes to reach the ending 10 meter mark. Record.
3. Find the velocity of the stream by using the formula V=d/t. Record.
4. Repeat step 2 in the center of the stream.
5. Where do you think the erosion is greatest? Record your answer.
6. Observe stream ecosytem. Brainstorm possible effects of increased sediment in stream from erosion on living things in the stream. Record all answers.
7. What might be some possible solutions to this problem? Record all reasonable answers.

EVALUATION: Have the group prepare an oral presentation of their findings which will be presented to the class by the group appointed spokesperson.

MAKING A DIFFERENCE: Become involved in the Adopt A Stream program where volunteers regularly monitor local streams for nonpoint source pollution. Contact The Clean Communities Coordinator at the Gloucester County Parks and Recreation office.

WELL WATER VS CITY WATER

Lesson Recommendations:

Grade: 8
Subject: Science
Skills: hypothesizing, analyzing data, comparing, experimenting, measuring
Merrill Correlation: Section 7-4
Setting: classroom
NJ Core Content Standard Correlations: 3, 4 , 5.2
Vocabulary: clarity, hardness
Time Allotment: two forty-minute class periods

OBJECTIVES: The student will be able to:
- Analyze and compare characteristics of tap city water and tap well water.
- Hypothesize about relationships between tested variables.
- Design and carry out an experiment to test these relationships.

METHOD: Students follow procedures to test the water samples for clarity, hardness, pH and taste. Students analyze and compare results, then attempt to describe a relationship between the tested variables. Once their hypotheses are stated, they design their own experiment to test the variables.

BACKGROUND INFORMATION Ninety nine percent of Glassboro's residents, businesses, etc. use city water. The remaining one percent on the outskirts of the borough still obtain their water from wells. (Armstrong, 1996) Variables tested will include clarity, or amount of particles in the samples, pH, hardness, and taste. The pH of natural waters is usually somewhere between 4 and 9. Commonly, water is found to be slightly basic because of the occurence of carbonate and bicaronate in the water. (LAB-AIDS, 1994) Analysis of Glassboro's drinking water tests show pH ranging from 8.16-8.55. (NJDEP, 1995) Hardness refers to the amount of certain minerals, such as dissolved calcium, magnesium, iron, or carbonate ions, present in water. Water which does not have these minerals is called soft water. Hard water can leave deposits on bathtubs, dishwashers, cooking utensils, and water heaters due to chemical reactions between minerals in the water and the soap. Soft water does not leave scum on any of the above mentioned items and less soap is needed to wash dishes or clothes. (Heimier & Neal, 1983)

MATERIALS NEEDED: pH paper, dishwashing soap, two 35-mm film canisters or other similar containers with lids, small paper cups, crackers, water samples, test tubes or beakers, white sheet of paper, science journal, pen or pencil.

PROCEDURE:

1. Prepare a data table to collect data.
2. Measure 25 ml of each sample and pour them into separate beakers. Examine each sample for clarity and amount of particles present in each. Place them side by side in front of a white piece of paper. Each sample should receive the same amount of sunlight. Record in chart.
3. Determine the pH of each sample using pH paper. Record in chart.
4. Using the film canisters or other similar container, fill them 3/4 with water. Label each container. Add a small drop of dish-washing liquid to each. Cap and shake 30 times.
5. Determine hardness by examining the suds. If foam forms immediately and the suds do not break down, the water is soft. If suds barely form and then leave a white scum on the water, the water is hard. Record in chart.
6. Test each of the samples for taste. Use the small paper cups, not any lab glassware! Eat a cracker between each test. Record your results. Ask several classmates their opinion of the taste.
7. Analyze your data to look for connections between the variables tested. Write down your hypothesis.
8. Design an experiment to test your hypothesis and show it to your teacher for approval and a designated lab time to perform it.

Predominant source: *Science Scope*, 1995

EVALUATION: Journal writing. Entry must include all data and observations, hypotheses and plans for experiment.

MAKING A DIFFERENCE: Whether you use city water or well water, help conserve this resource by taking shorter showers, turning off the faucet when brushing your teeth, encourage your family to wash the car only when necessary.

IS ABBOTT POND POLLUTED?

Lesson Recommendations:

Grade: 8
Subject: Science, Math, Language Arts, Social Studies
Skills: analyzing data, measuring, following directions, comparing
Merrill Correlation: Section 7-4
Setting: Classroom, Abbott Pond (behind college dorms on Carpenter St.), 10 minute walk from GIS
NJ Core Content Standard Correlations: 3, 4, 5, 3.3, 4.6, 4.9, 5.1, 5.2, 5.5, 5.12, 6.9
Vocabulary: pollutants
Time Allotment: one eighty-minute class period. Arrangements must be made to double up class periods.

OBJECTIVES: The student will be able to:
° Follow directions accurately to test for water pollutants.
° Summarize results in a written format.
° Make a written assessment of the quality of the tested water.

METHOD: Students, working in groups, using LAB-AIDS, Cat. #19, Qualitative Introduction to Water Pollution, will perform 10 tests which will indicate the presence of pollutants by color changes.

BACKGROUND INFORMATION: Impurities of any kind mixed with water cause pollution. There are many kinds of water pollution. Water may become polluted by sewage, chemicals from industries or factories dumped directly into the water or from rain which washes fertilizers and pesticides into waterways. At one time, nature could take care of the impurities itself but at the rate that the pollutants are entering our waterways today, this is no longer the case. (LAB-AIDS, 1994) This particular kit was chosen for this grade level because of the ease of detection of pollutants. If students follow the directions carefully, a simple color change will indicate the presence of the pollutant. It is recommended that the teacher become familiar with the test procedures and what each test will indicate before taking the students to the pond. The instruction book that comes with the kit is very informative. Ready made handouts for the students also come with the kit. It is recommended they be put in plastic covers before taking them to the pond. LAB-AIDS, Inc. Kits can be ordered by writing to 17 Colt Court, Ronkonkoma, NY 11779 for a catalog.

MATERIALS NEEDED: Copies of directions (encased in plastic) for students, clipboards, carrying cases for test materials, LAB-AIDS, #19 kit, data sheet, pen or pencil.

PROCEDURE:

1. Before leaving the classroom, review with students: all instructions thoroughly, assignments of tests to each group member, expected behavior on the excursion, personally and with regard to the natural environment they will be exploring.

2. Once at the site, distribute instruction sheets and test materials. Allow students to work independently, only monitoring progress as necessary.

3. When all groups have completed the tasks, be sure to leave the site as it was found if not better. (This might be a good opportunity to model for students recycling and litter pick up.)

4. Back in the classroom, advise students to create a written format to summarize their results. The format is their choice; table, diagram or written essay.

5. Instruct students to analyze their data and write an essay on why they think the pond is polluted or not polluted using facts obtained from their testing. Inform them the summary of results and written essay will be due in two days.

Predominant source: *LAB-AIDS*, Inc., 1994

EVALUATION: Evaluate summaries of results by comparing individual results with your own and other class members. Evaluate essay using the Registered Holistic Scoring method.

MAKING A DIFFERENCE: Protect your local waterway by becoming involved in the New Jersey Water Watch Program sponsored by NJDEP. Volunteers are trained to look for certain problems and to call the proper authority if found. Contact: NJDEP, Office of Enforcement Coordination CN 22, Trenton, NJ 08625.

Name _____

IS ABBOTT POND POLLUTED? DATA SHEET

PURPOSE: To perform a series of water pollution tests and determine if Abbott Pond is polluted by analyzing the results.

MATERIALS: instruction sheet, LAB-AIDS #19 kit, clipboard, data sheet, pen or pencil

PROCEDURE:

1. FOLLOW ALL DIRECTIONS EXACTLY AS STATED ON INSTRUCTION SHEET.

DATA TABLE:

TEST	Detectable color change (YES/NO)	COLOR
Ammonia nitrogen		
pH		
Chlorine		
Chromium		
Copper		
Cyanide		
Iron		
Nitrate Nitrogen		
Phosphorus		
Silica		
Sulfide		

FOLLOW UP: Analyze data and summarize results in a written format of your choice. (table, diagram or written in paragraph form.) Write an essay explaining why you think the pond is polluted or not polluted using facts obtained from your testing. The summary of results and the essay will be due in two days.

DUE DATE: _____

WHERE IS YOUR WATERSHED?

Lesson Recommendations:

Grade: 8
Subject: Science, Geography
Skills: map reading, diagramming, following directions
:Merrill Correlation: Section 7-2, 8-3
Setting: classroom
NJ Core Content Standard Correlations: 3, 4 , 5.1, 5.10, 5.12, 6.7
Vocabulary: topographic map, contour line, contour interval, hachure lines
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
°Interpret a topographic map.
°Explain that contour lines V where they cross water ways.
°Find the highest contour line adjacent to local waterways.
°Use the highest contour lines to trace the watershed on paper on top of the topo map.

METHOD: After practice using topo maps, students will outline their local watershed on tracing paper placed on top of topo maps of the Glassboro area.

BACKGROUND INFORMATION Topographic maps show the surface features of an area such as mountains, hills, depressions, ponds, streams, etc. It also shows cultural features built by people such as roads, cities, dams, etc. Contour lines are lines on a topographic map that connect points of equal elevation. The difference between adjacent contour lines is called the contour interval. The size of the contour interval depends on the lay of the land. If the land is very steep, the contour interval would be large, maybe 100 feet. However, if there wasn't much change in elevation, the contour interval might be small, maybe 10 feet. There are some general rules to remember when using topo maps: 1) contour lines close around hills or depressions (to determine if it is a hill or depression, read the elevation or look for hachure lines, short lines at right angles to the contour line; 2) contour lines never cross; and 3) contour lines form Vs that point upstream whenever they cross streams. Standard topographic maps or quadrangles of Glassboro can be purchased from the United States Geologic Survey (USGS). A watershed is the area of land that drains into a river, lake or stream. It includes the waterways and the entire land area that drains into it. How land is used can have a direct impact on the quality of water in the watershed. Glassboro belongs to the Mantua Creek watershed. (Hoffmann, 1988)

MATERIALS NEEDED: Glassboro quadrangles, at least one for every two students, white tracing paper, Appendix H from Merrill Earth Science, pencil.

PROCEDURE:

1. Review terms associated with topo maps.
2. Distribute topo maps to students. Students should look for the contour interval, highest point, lowest point, evidence of depressions, topographic evidence of streams (Vs). Once students find a water way have them determine the direction the stream is flowing. (Remember the Vs point upstream) Have the students locate their neighborhoods, Abbott Pond, Mantua Creek.
3. Next, explain to students what a watershed is and that watersheds are divided from other watersheds by ridge top boundaries.
4. Distribute a piece of tracing paper to each pair of students and have them locate the highest contour lines on the map. Using these points as a guide, outline the area that would drain into the nearest waterway.

EVALUATION: Make sure students can read topo maps by having them complete the problem solving activity on page 211. Have one student pair compare their diagrams with the other student pair's at the table.

MAKING A DIFFERENCE: Find the nearest boundary of the watershed to your home. Walk along the boundary with family or friends and pick up and recycle any trash along the way to prevent it from entering the waterways.

WHERE DOES THE RUNOFF GO?

Lesson Recommendations:

Grade: 8
Subject: Science, Math
Skills: observing, describing, measuring, calculating, analyzing, interpreting
Merrill Correlation: Section 7-1
Setting: school parking lot
NJ Core Content Standard Correlations: 3, 4, 4.1, 4.3, 4.5, 4.7, 5.1, 5.2, 5.5, 5.12
Vocabulary: area, runoff, precipitation
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
- Measure the length and width of the school parking lot.
- Calculate the area of the school parking lot.
- Determine the amount of runoff that would occur if 1/2 inch rain fell on the parking lot.
- Predict where all the runoff will end up.

METHOD: Students physically measure the length, width of their school parking lot, calculate its area, solve problems related to the amount of rain fall and postulate theories as to where the water may go.

BACKGROUND INFORMATION Water, though a renewable resource, is also a finite resource. It is exchanged between the Earth and the atmosphere by the water cycle. The sun is the major force which drives the water cycle. The sun evaporates surface water into water vapor. As it is carried into the atmosphere, the air cools down forcing the water vapor to condense, forming clouds. When enough condensation droplets come together, precipitation occurs in the form of rain, sleet, snow or hail. Annually, New Jersey receives 44 inches of rainfall. Twenty-four inches are lost back to the atmosphere by evaporation and transpiration (the process by which water escapes from plants and gets into the atmosphere.) About 17 inches soak into the ground and the rest becomes runoff, water that runs along the surface of the land. (League of Women Voters of NJ Education Fund, 1987) It most likely will find its way eventually to a body of water. However, along the way it will erode the land surface and could also possibly pick up nonpoint sources of pollution, such as animal waste, pesticides or fertilizers, which could find its way into our local water bodies.

MATERIALS NEEDED: Calculators, science journal, pen or pencil, means of measuring length and width. (measuring tape, rope marked off every 10 feet, etc.)

PROCEDURE:

1. Review with students guidelines for behavior outside.
2. Measure as accurately as possible, the length and width of the school parking lot. Record all data in science journal.
3. Using calculators, find the area of the parking lot. (A= L X W)
4. If one half inch of rain fell on the parking lot, how much water would run off? (Area X .5 in = ? inches cubed) Use calculator.
5. Observe surrounding area, where will this water eventually go?
6. In its travel what effects might it have on objects or living things which cross its path?

Predominant Source: *EPA Journal*, 1994.

EVALUATION: In their science journals ask students to reflect and respond to the following questions after their experience. How have human activities affected the quality of runoff? How have human activities affected the quantity of runoff? How does runoff affect humans? How does runoff affect wildlife?

MAKING A DIFFERENCE: To avoid getting pollutants into our waterways by runoff, obey pooper scooper laws for pets and always pick up after your pet; plant native plants so there is no need for fertilizer.

SCHOOL PROPERTY
WATERSHED

Lesson Recommendations:

Grade: 8
Subject: Science, Language Arts, Social Studies
Skills: analyzing data, estimating, comparing, observing, drawing
Merrill Correlation: Section 7-3
Setting: school grounds, classroom
NJ Core Content Standard Correlations: 3, 4, 5, 3.1, 5.1, 5.2, 5.12, 6.9
Vocabulary: watershed, slope, gully, ditch
Time Allotment: two forty-minute class periods

OBJECTIVES: The student will be able to:
- Map, by diagram, features of the school property such as slope, gully, ditch.
- Predict how the school property will act as a watershed.
- Compare earlier predictions with actual observations after rain storm.
- Evaluate the school property as a watershed.

METHOD: Students will take two walks around their school, one on a dry day, the other after a rain storm. On the first trip, students note where runoff may occur and where tiny streams could form. They record their predictions of what would happen during and after a rain storm. After a heavy rainstorm, students take another trip to compare their earlier predictions with actual observations.

BACKGROUND INFORMATION A watershed is the area of land that drains into a river, lake or stream. It includes the waterways and the entire land area that drains into it. A lake's watershed may include the streams entering into it, the hills draining into the stream. How land is used can have a direct impact on the quality of water in the watershed. Glassboro belongs to the Mantua Creek watershed. (Hoffmann, 1988)

MATERIALS NEEDED: Clipboard, writing utensil, science journals.

PROCEDURE:

1. Before leaving the classroom, remind students of proper expected behavior on the field trip.
2. On the first trip around the school property, make careful observations about it, indicating on a drawn diagram of the school property where slopes, gullies, ditches and any other areas where runoff might occur and tiny streams could form.
3. Record predictions of what might happen after a heavy rain storm. Save for future use.
4. Take a second trip after a heavy rain storm. Compare earlier predictions with actual observations.
5. Answer the following questions in science journal. Where did water movement occur? Where did water collect? Where did most of the water go? What manmade features, if any prevented flooding? What natural features deterred flooding?
6. Use observations and answers to the questions above to write a paragraph evaluating your school property as a watershed.

Predominant Source: *Beneath the Shell*, 1991

EVALUATION: Read student essays in science journals evaluating school property as a watershed. Accept conclusions with logical facts backing them up.

MAKING A DIFFERENCE: Nonpoint source pollution is the biggest threat to our watersheds. Conserving water through efficient water use can help prevent nonpoint source pollution because using less water reduces the runoff of agricultural pollutants, pesticides and fertilizers.

CLEANING DIRTY WATER

Lesson Recommendations:

Grade: 8
Subject: Science, Language Arts
Skills: observing, hypothesizing, analyzing data, planning, creating, public speaking
Merrill Correlation: Section 7-4
Setting: classroom
NJ Core Content Standard Correlations: 3, 4 ,3.1, 3.2, 5.1, 5.2, 5.12
Vocabulary: pollutants, filter
Time Allotment: two forty-minute class periods

OBJECTIVES: The student will be able to:
° Invent a simple system to separate pollutants from water.
° Explain how pollutants can be separated from water.
° Demonstrate how invention works to the class.

METHOD: Students design and build simple water filtration systems with simple materials provided by the teacher or brought to school by them which cleanse the polluted water given to them.

BACKGROUND INFORMATION Surface water and groundwater quality can be affected by different factors. As water runs along the surface it may undergo physical and chemical changes; these changes can be natural or man made. Just as water can dissolve desirable minerals which are necessary for plant growth, water can also dissolve minerals and chemicals which could pollute our surface and ground water supplies. Water may dissolve pesticides and fertilizers on the land or mix with chemicals in the air. Naturally occurring events like landslides, volcanic eruptions and forest fires may introduce pollutants into the water. Human activities such as construction, agricultural practices, logging, and mining introduce others. Major pollutants of water are: natural organic materials, such as plant debris and human waste; sediment; nutrients, such as nitrogen and phosphorus which are detrimental to pond ecosystems when present in abundance; and toxic substances, such as insecticides and herbicides. The sources of these pollutants may be either point source, we know exactly where they are coming from, or nonpoint source, which can not be easily identified or controlled. While complex factors affect the rate and quantity of pollutants that enter the waterways, individuals must understand that anything put on or under the land's surface has the potential to pollute our surface and ground water supplies. (Vandas, 1994)

MATERIALS NEEDED: For teacher to create muddy, murky or "polluted" water: sand, scraps of paper, vegetable oil, gravel, salt, food coloring.

For students, working in groups, to make filtration device: sand, panty hose, cotton, coffee filters. (or any other materials you or your students can think of)

PROCEDURE:

1. Display the jars of polluted water you have created with the materials listed above.
2. Explain to the students that you have this problem of polluted water. Their job will be first to determine the type of pollution that has occurred, then to invent a filtration device that will clean up the pollution. The student materials listed above may be used or materials of the student's choice with teacher approval.
3. Allow students ample time to design their inventions. Monitor and provide assistance when needed.
4. At the next class period, or when you deem a reasonable time period has elapsed, have the groups demonstrate and explain how their invention works.

Predominant Source: *EPA Journal*, 1994

EVALUATION: Use a peer evaluation designed by you to have other groups assess the inventions.

MAKING A DIFFERENCE: Initiate a Drinking Water Awareness Week for your school to make others aware of the importance of protecting our drinking supply from pollution.

STORM DRAIN SURVEY

Lesson Recommendations:

Grade: 8
Subject: Science, Math, Language Arts, Social Studies
Skills: map reading, estimating, classifying, hypothesizing, analyzing data, planning
Merrill Correlation: Section 7-1
Setting: classroom, storm drains bordering Intermediate School on MacClelland and Focer Street
NJ Core Content Standard Correlations: 2, 3, 4 ,3.1, 3.2, 4.1, 4.8, 5.1, 5.2, 5.5, 5.12, 6.9
Vocabulary: non point source pollution
Time Allotment: three, forty-minute class periods

OBJECTIVES: The student will be able to:

- Describe human activities that cause non point source pollution and the effect on the environment.
- Recognize the need for decision making and behaviors that encourage conservation and preservation through the efficient and productive use of natural resources.
- Estimate, then measure the distance of any man made or natural material visible within 10 feet of the storm drain.

METHOD: Students observe and take note of the nonpoint source pollution found in storm drains close to school. Students analyze data from each group and hypothesize likely contributors of NPS pollution. Finally, the class designs a method for reducing the amount of NPS pollution in that area.

BACKGROUND INFORMATION Water resulting from rain, snow melting, ice, etc. , i.e., stormwater , flows along the ground to storm drains. Storm drains lead to a system of pipes lying underneath the streets. These pipes usually carry the stormwater right into waterways. Stormwater may pick up pollutants and contaminates along the way which may eventually be deposited into the waterways. Non point source pollution, or NPS, is pollution that is "diffuse and does not have a single point of origin or is not introduced into a receiving stream of water from a specific outlet." (NJDEP, 1991) Examples of NPS include: sediment, excessive nutrients, animal waste, pesticides, toxic metals, acidic deposition, motor oil, household hazardous waste, road salts, and litter. (NJDEP, 1991) NJDEP cites NPS as a result of human activities as a major cause of water quality degradation in the state. Their plan for water quality protection will focus on non point sources through aquifer recharge protection, well head protection, and acquisition of water supply watershed lands. (NJDEP, 1995)

MATERIALS NEEDED: Local maps, measuring tape, flashlights, one per group, clipboards, record sheets, transparencies for compiling class data, overhead projector, pen or pencil.

PROCEDURE:

1. Define storm drain. Discuss function of storm drains. Discuss and give examples of NPS pollution.

2. Survey a map of the surrounding roads bordering school. Locate storm drains. Assign a storm drain to each group.

3. (AT THE SITE) Describe and list on record sheet any man made or natural material visible within 10 feet of the drain. Record an estimate of the distance of each object to the drain, then accurately measure the distance with a tape measure and record.

4. Shine a flashlight into the drain, record visible NPS pollution inside drain.

5. (BACK IN THE CLASSROOM) Hypothesize likely contributors of NPSP. Make list on overhead transparency. Analyze class data. Refine, revise list of possible contributors of the NPS pollution.

6. Design a method for reducing the amount of pollution in that area.

   NOTE: Some advanced planning is needed. It will be necessary to have parent volunteers or teacher aides or even teachers who have free time to help monitor groups at the various storm drain sites.

   Predominant source: *Beneath the Shell*, 1991.

EVALUATION: Have each group turn in a project portfolio including: chart with records of measurement, observations from field trip, brainstormed list of possible NPSP contributors, revised list after analysis of class data, group designed method of NPS reduction, and peer evaluation of cooperation of group members.

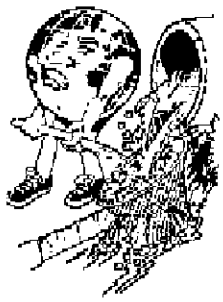
MAKING A DIFFERENCE: Write letters of concern to the offenders and submit your plan for reducing amount of NPSP. Attend a Boro Council meeting and submit your plan for reducing NPSP.

Name_____
STORM DRAIN SURVEY RECORD SHEET

Location of storm drain: _____

Outside Visible NPS	Estimated Distance	Actual Distance

Inside Visible NPS	Estimated Distance



Possible list of NPS polluters:	Revised list of polluters:

WETLANDS MODEL

Lesson Recommendations:

Grade: 8
Subject: Science, Language Arts, Social Studies
Skills: observing, describing, comparing, measuring, analyzing, interpreting
Merrill Correlation: Section 7-4
Setting: classroom
NJ Core Content Standard Correlations: 3, 4, 3.3, 5.1, 5.2, 5.12, 6.9
Vocabulary: groundwater, surface water, wetland, deepwater habitat, saltwater, freshwater
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
° Create a model of a wetland.
° Describe what a wetland is and the diversity of different wetland types.
° Discuss two functions common to different wetland types.

METHOD: Students will create a model wetland, and observe and discuss what happens to it as they manipulate it through different scenarios.

BACKGROUND INFORMATION Wetlands are transitional areas between land and deepwater habitats, those that are permanently flooded lands lying below the deep water boundary of wetlands. (Vandas, 1993) Wetland areas include: marshes (salt and freshwater), swamps, bogs, (cranberries and blueberries grow in bogs; N.J. is #1 in cranberry production), estuary, (where salt and fresh water mix), wet meadows. People use wetlands for hunting, fishing, bird watching, boating, hiking, and as a source of food. Other living things which use them include: migratory birds, fish, crustaceans, reptiles and amphibians, mammals like muskrat, beaver and white tailed deer. Wetlands provide numerous benefits. They absorb excess water; act as a flood control. They provide a resting place for migratory birds. They mix nutrients and oxygen into the water. They act as a nursery by taking care of the needs of young wildlife. Wetlands can strain silt and debris from water and filter out smaller impurities. In fact, some areas use wetlands as part of their wastewater treatment process because they are so efficient at cleaning. They also provide us with a lot of food. (WREEC, 1987) Unfortunately, the U.S. has lost one half of its 200 million acres of wetlands. In the 1800's, Congress gave away 65 million acres. We lose 300, 000 acres every year, that's 34 acres every hour. Eighteen percent of New Jersey is wetlands. Gloucester County has about 13,000 acres and Glassboro has about 200. Just a few examples are behind Bullock School and Willow Trace. Many other sites exist. (Junod, 1993)

MATERIALS NEEDED: For each group of four: 23 x 33 cm baking pan or similar container, modeling clay, 23 cm x 13 cm x 8 cm, sloped to 3 cm, (represents land), small piece of indoor-outdoor carpet, 23 cm x 10 cm, (represents wetland) 200 ml of water, 5 tablespoons of soil, tree needles, twigs, grass, cotton swabs (to represent cattails), small plastic animals and people (optional), instruction sheet for building model and record sheet, pen or pencil.

PROCEDURE:

1. After discussing functions and different types of wetlands with students, distribute materials and instruct students to use the variety of materials available to build different kinds of wetlands.
2. Check models before students begin. Make adjustments as necessary.
3. Instruct students to follow directions on handout and record their observations and answers to the questions.
4. Give instructions for clean up when students are through.

Predominant Source: *Science Scope*, 1993.

EVALUATION: After performing the investigation and observing other models in the room, students should be able to explain in oral or written form at least two different types of wetlands, and two functions that all wetland types have in common.

MAKING A DIFFERENCE: Do research on wetlands in your area. Find exactly where they are and what you can do to protect them. Share the information with your family members.

Name _____

WETLANDS MODEL

PURPOSE: To observe, through experimentation, the beneficial qualities of wetlands.

MATERIALS: 23 x 33 cm baking pan or similar container, modeling clay, 23 cm x 13 cm x 8 cm, sloped to 3 cm, (represents land), small piece of indoor-outdoor carpet, 23 cm x 10 cm, (represents wetland) water, 5 tablespoons of soil, tree needles, twigs, grass, cotton swabs (to represent cattails), small plastic animals and people (optional), instruction sheet for building model and science journal, pen or pencil, graduated cylinder.

PROCEDURE:

1. Read through all directions carefully before beginning. Record all data and observations in your science journal.
2. Spread a sloping layer of clay in one third of the pan to represent land. Make sure the clay is sealed to the pan on the edges to prevent water from getting underneath.
3. Form streams in the clay.
4. In the middle one third of the pan put the cut piece of indoor-outdoor carpeting (wetlands) to completely fill the space between the clay and the body of water. (The remaining 1/3 of the pan is the body of water.)
5. Place some of the model building materials on both the land and wetlands to represent plants, animals, and people.
6. Measure 100 ml of water and pour it over the land. Record your observations.
7. Remove the wetland and measure the amount of remaining water. Record.
8. With the wetlands removed, pour another 100 ml of water over the model. Record observations.
9. Pour the water out and measure it. Compare this number to the answer you received for Step 7.
10. Put the wetland back in place. Pour soil over the land. Slowly pour water over the land. Compare water in wetland with water poured over land. Record.
11. Examine the wetland and record observations.
12. Pour out the water. Remove the wetland and repeat Step 10. Record observations. Follow teacher's instructions for clean up.

FOLLOW UP: Answer the following questions in complete sentences in your science journal.

1. How can muddy water affect fish and wildlife?
2. How does sediment affect other water uses?
3. Describe the characteristics of two different types of wetlands.
4. Explain two functions that all wetland types have in common.

From: *Science Scope*, 1993.

WETLANDS METAPHORS

Lesson Recommendations:

Grade: 8
Subject: Science, Language Arts
Skills: inferring, describing, comparing, analyzing, interpreting
Merrill Correlation: Section 7-4
Setting: classroom
NJ Core Content Standard Correlations: 3, 4, 3.3, 5.1, 5.2, 5.12, 6.9
Vocabulary: wetlands, metaphor
Time Allotment: one forty-minute class period

OBJECTIVES: The student will be able to:
° Identify the functions of wetlands.
° Demonstrate an understanding of the importance of wetlands to wildlife and humans.

METHOD: Students brainstorm in small groups how the object they were given can serve as a metaphor for a wetland function.

BACKGROUND INFORMATION Wetlands are transitional areas between land and deepwater habitats, those that are permanently flooded lands lying below the deep water boundary of wetlands. (Vandas, 1993) Wetland areas include: marshes (salt and freshwater), swamps, bogs, (cranberries and blueberries grow in bogs; N.J. is #1 in cranberry production), estuary, (where salt and fresh water mix), wet meadows. People use wetlands for hunting, fishing, bird watching, boating, hiking, and as a source of food. Other living things which use them include: migratory birds, fish, crustaceans, reptiles and amphibians, mammals like muskrat, beaver and white tailed deer. Wetlands provide numerous benefits. They absorb excess water; act as a flood control. They provide a resting place for migratory birds. They mix nutrients and oxygen into the water. They act as a nursery by taking care of the needs of young wildlife. Wetlands can strain silt and debris from water and filter out smaller impurities. In fact, some areas use wetlands as part of their wastewater treatment process because they are so efficient at cleaning. They also provide us with a lot of food. (WREEC, 1987) Unfortunately, the U.S. has lost one half of its 200 million acres of wetlands. In the 1800's, Congress gave away 65 million acres. We lose 300, 000 acres every year, that's 34 acres every hour. Eighteen percent of New Jersey is wetlands. Gloucester County has about 13, 000 acres and Glassboro has about 200. Just a few examples are behind Bullock School and Willow Trace. Many other sites exist. (Junod, 1993)

MATERIALS NEEDED: A large pillowcase, bag or similar container to hold all the objects; sponge, pillow or bed, electric mixer, cradle, strainer, coffee filter, antacid, cereal, soap, can of clam chowder, science journal, pen or pencil, cassette tape of natural wetland sounds.

PROCEDURE:

1. Gather the objects listed above and fill your container with the objects before the lesson takes place.

2. Discuss with the students the different kinds of wetlands that exist in New Jersey. Play a tape recording of wetland sounds (available at nature stores) for students. Tell them to close their eyes and picture what the wetland looks like and what living things might be there.

3. Encourage students to share what they imagined.

4. Using their images as a springboard begin to discuss the different activities which occur in wetlands.

5. Introduce the term metaphor. Explain that you will give each group an object that is a metaphor for an actual wetland function.

6. Have one student from each group pick an object out of the container. Students should then discuss in small groups what they think the object represents. Tell them to be prepared to share their ideas with the class.

7. As groups display their objects and summarize the results of their own discussion, encourage discussion among the whole class which examines the importance of wetlands to humans and wildlife.

Predominant Source: *Project Wild Aquatic*, 1987

<u>Possible Wetland Metaphors:</u>

Soap = cleanses environment
Cereal = provides food
Antacid = neutralizes toxics
Coffee filter = filters impurities
Strainer = strains silt, debris
Cradle = nursery for wildlife
Mixer = mix nutrients and oxygen into water
pillow or bed = resting place for birds
Sponge = flood control

EVALUATION: Look for points from discussion in students' science journal as they respond to the question, why are wetlands considered one of the most productive ecosystems that exist?

MAKING A DIFFERENCE: Find out what local laws govern the use of wetlands in your town.

A WATER AWARENESS TEST FOR YOU AND YOUR FAMILY

Lesson Recommendations:

Grade: 8
Subject: Science, Math
Skills: comparing, analyzing, observing, reporting, describing, discussing, computing
Merrill Correlation: Section 7-4
Setting: home
NJ Core Content Standard Correlations: 3, 4.3, 5.2, 5.5, 5.12
Vocabulary: conservation
Time Allotment: 10 minutes class time to explain, 20-30 minutes at home to complete

OBJECTIVES: The student will be able to:
- Complete a survey.
- Use a predeveloped scale to determine their water awareness.
- Describe additional measures to take to conserve water.

METHOD: Students, with the help of their families, will determine their water awareness by completing a survey.

BACKGROUND INFORMATION People tend not to view water as the important resource that it is because when they look around, it is everywhere. Why bother to protect it or conserve it, there will always be more. Actually, scientists believe the water we have on Earth right now is all the water we will ever have. (WREEC, 1987) People must understand that we have a responsibility to protect and conserve it. Everyday, people do or avoid doing things which affect the amount and quality of the water people use. This survey will give students and their families the opportunity to determine if they are a part of the problem or a part of the solution when it comes to water conservation.

MATERIALS NEEDED: Water awareness test, pen or pencil.

PROCEDURE:

1. Distribute a water awareness sheet to each students.
2. Explain that they are going to take these surveys home and complete them as honestly as possible with their families. They will need about 20-30 minutes of family time to do this.
3. When the survey is finished, they should add up their score and find out how they stand on water resource issues. Families should then spend a few minutes discussing their results and the implications of the results for them as a family.
4. Tell the students to be prepared to discuss their findings in class.

Predominant source: *America's Clean Water Foundation*, 1992

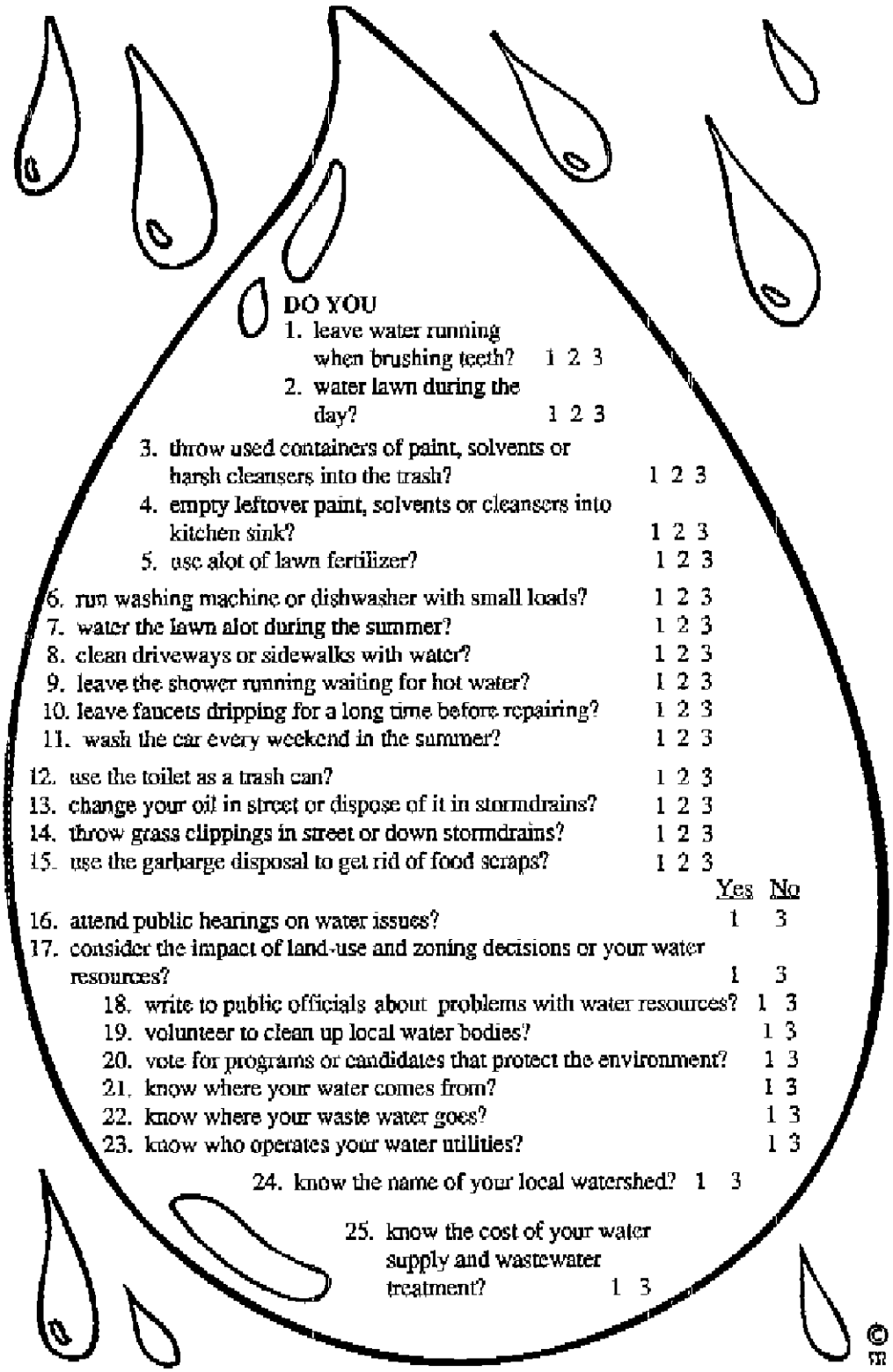
EVALUATION: Science Journal Writing: Ask the students to write about their experiences with the survey and their family and how they felt about it. Where do they fit in on the conservation scale? What does their family intend to do about it? What can they personally do to help their family achieve their water conservation goal?

MAKING A DIFFERENCE: Follow through with the suggestions for additional measures to be taken on the survey sheet. Encourage family members to do the same.

Name _____

WATER AWARENESS TEST

Directions: Complete the checklist then add up your score. See the back for further instructions. Rating Scale: 1= Never 2= Sometimes 3= Often



DO YOU

1. leave water running when brushing teeth? 1 2 3
2. water lawn during the day? 1 2 3
3. throw used containers of paint, solvents or harsh cleansers into the trash? 1 2 3
4. empty leftover paint, solvents or cleansers into kitchen sink? 1 2 3
5. use alot of lawn fertilizer? 1 2 3
6. run washing machine or dishwasher with small loads? 1 2 3
7. water the lawn alot during the summer? 1 2 3
8. clean driveways or sidewalks with water? 1 2 3
9. leave the shower running waiting for hot water? 1 2 3
10. leave faucets dripping for a long time before repairing? 1 2 3
11. wash the car every weekend in the summer? 1 2 3
12. use the toilet as a trash can? 1 2 3
13. change your oil in street or dispose of it in stormdrains? 1 2 3
14. throw grass clippings in street or down stormdrains? 1 2 3
15. use the garbarge disposal to get rid of food scraps? 1 2 3

	Yes	No
16. attend public hearings on water issues?	1	3
17. consider the impact of land-use and zoning decisions or your water resources?	1	3
18. write to public officials about problems with water resources?	1	3
19. volunteer to clean up local water bodies?	1	3
20. vote for programs or candidates that protect the environment?	1	3
21. know where your water comes from?	1	3
22. know where your waste water goes?	1	3
23. know who operates your water utilities?	1	3
24. know the name of your local watershed?	1	3
25. know the cost of your water supply and wastewater treatment?	1	3

Add up your total from the previous page and record it here. **TOTAL:** ____

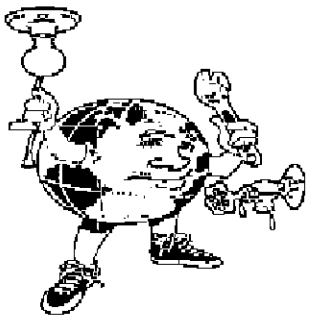
Read the information below to determine what your score means and what more you can do to conserve water.

YOUR SCORE

30 OR LESS	31 TO 55	56 TO 75
You know a lot about water resources issues. You should be commended for your continued practice of water conservation.	Although you know enough about water resource issues and believe in the need to conserve water, you are not as regular in your water conservation habits as you could be.	Right now, your habits are contributing more to the problem of water conservation than to its solutions. It is time to buckle down and start conserving water.

WHAT ELSE YOU CAN DO

30 OR LESS	31 to 55	56 to 75
Continue to do as you have done. Encourage family and friends to do the same.	Complete a home water usage survey so you can find out where water is being wasted. Based on your findings, begin water conservation practices.	Read up on water resources and conservation. Implement the practices you learn about. Join a local group who is committed to protecting this precious resource.



HOW MUCH WATER DO YOU USE?

Lesson Recommendations:

Grade: 8
Subject: Science, Math
Skills: computing, comparing, graphing, analyzing, observing, reporting, applying
Merrill Correlation: Section 7-4
Setting: classroom, home
NJ Core Content Standard Correlations: 3, 4.1, 4.2, 4.5, 4.8, 5.2, 5.5, 5.12
Vocabulary: conservation
Time Allotment: 10 minutes to explain at home directions, two forty-minute periods for data analysis

OBJECTIVES: The student will be able to:
- Calculate, using a given chart, and track daily water usage for a week.
- Suggest methods for conserving water.
- Apply water conservation techniques.
- Compare pre conservation data to post conservation data.
- Construct a bar graph which shows comparisons of pre and post conservation data.

METHOD: Students keep a daily water usage log. After a week, students bring their data to class and discuss methods of conserving water. Students keep a daily water usage log again, this time using the water conservation methods. Students then compare individual results to class results.

BACKGROUND INFORMATION People tend not to view water as the important resource that it is because when they look around, it is everywhere. Why bother to protect it or conserve it, there will always be more. Actually, scientists believe the water we have on Earth right now is all the water we will ever have. (WREEC, 1987) People must understand that we have a responsibility to protect and conserve it. On average, Americans use about 150 gallons of water a day. Most of this water is used in the home. Of the total public water supply, about 57 percent goes for domestic uses, 11 percent for public uses such as fire fighting, watering parks, and cleaning streets, and the other 32 percent is used by business and industry. (Rivera &Banbury, 1987) The Glassboro Water & Sewer Department relies on public education to promote water conservation and the local ordinance which prohibits lawn watering between the hours of 10:00 a.m. and 6:00 p.m.

MATERIALS NEEDED: Water tracking sheet, calculator, graph paper, pen or pencil.

PROCEDURE:

1. Distribute water tracking sheet to students.
2. Inform them they are going to monitor their water usage every day for a week.
3. Using the chart provided on the water tracking sheet, place a tick mark or the number of minutes next to the matching item.
4. At the end of each day, calculate and record the amount of water you used.
5. After a week has passed, have the students bring the data into class. Calculate the amount of water used by the whole class, for a day, week and year. Compare individual totals to other class members.
6. Discuss various methods of water conservation.
7. Repeat #3 but try to be conscious of conserving water for the next week.
8. At the end of the second week, have students bring in their data again. Discuss class results. Have students make a bar graph showing their daily water usage normally and then after practicing conservation techniques.

Predominant source: *Science Scope*, 1994.

EVALUATION: Have students write a self evaluation of their differences in water usage, methods they personally used to conserve water and how they felt doing it.

MAKING A DIFFERENCE: Periodically monitor your water usage throughout the year to continue using water conservation practices. Make water conservation posters and hang them around school or ask to display them in local business shops.

Name_____

HOW MUCH WATER DO YOU USE? RECORD SHEET

Directions: Each day for a week, place a tick mark next to what you used water for or the number of minutes for which you used water. At the end of the day, calculate and record the amount of water you used.

Water Usage	Sun.		Mon.		Tues.		Wed.		Thur.		Fri.		Sat.	
	#	T	#	T	#	T	#	T	#	T	#	T	#	T
Toilet flush = 6 gallons														
Shower sprays 7 gallons per minute														
Faucet emits 2 gallons per minute														
Outdoor hose discharges 10 gallons per minute.														
Washing machine = 34 gallons														
Dishwasher = 17 gallons														
Bath = 40 gallons														
Daily Total														

from *Science Scope*, 1994

At the end of this week, bring in your tracking sheet to compare data with your classmates. We will discuss some water conservation techniques. You should record ideas for water conservation below. Using these ideas, you will again track your water usage for one week. A new sheet will be distributed to you at that time. At the end of the second week, bring both sheets back to school for comparisons and discussion.

Record Water Conservation Techniques here:

WHERE DO YOU STAND?

Lesson Recommendations:

Grade: 8
Subject: Science, Language Arts
Skills: comparing, analyzing, observing, reporting, describing, discussing
Merrill Correlation: Section 7-4
Setting: classroom
NJ Core Content Standard Correlations: 3, 3.1, 3.2, 5.12
Vocabulary: conservation
Time Allotment: two forty-minute class periods

OBJECTIVES: The student will be able to:
- Determine his/her own position on water conservation.
- Conduct an interview as a method of research.
- Use supporting arguments to strengthen position on an issue.
- Evaluate the strengths and weaknesses of their own position based on the supporting arguments.

METHOD: Students will role play different members of the community to examine the varying viewpoints toward protecting and conserving water.

BACKGROUND INFORMATION People tend not to view water as the important resource that it is because when they look around, it is everywhere. Why bother to protect it or conserve it, there will always be more. Actually, scientists believe the water we have on Earth right now is all the water we will ever have. (WREEC, 1987) People must understand that we have a responsibility to protect and conserve it. Students often believe that they do not have the ability to make a difference in the world. (Rivera & Banbury, 1994) Water conservation can promote social responsibility and environmental responsibility because it is a resource that everyone uses and one that everyone will need in the future. In addition to learning about water conservation techniques, students must be given opportunities to examine and clarify their own as well as society's values concerning water. (Rivera & Banbury, 1994)

MATERIALS NEEDED: Role play assignment sheet, notebook or tape recorder for interviews, pen or pencil.

PROCEDURE:

1. Each group will be assigned or choose a role from the handout.
2. Two group members choose to role play one position and the other two the opposing position for that assignment.
3. Each student should interview community members who really prescribe to that role. Students should use the information they receive from their interviews to prepare their in-class role.
4. Each student gets to present her/his argument to the class. Allow time for questions and discussion.
5. Have students think about and evaluate their presentations by asking such questions as: Did I present a realistic argument? What were the strengths and weaknesses of my presentation? What new things did I learn regarding my position or the opposing position?
6. Through class discussion, suggest actions that the different community members could take to conserve water.

Predominant source: *Science Scope*, 1994.

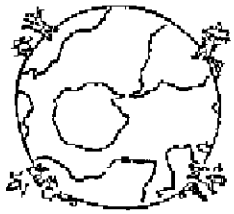
EVALUATION: Using teacher evaluation, self evaluation, peer evaluation, or a combination of all three, assess the performance based on supporting arguments, delivery of information, and research.

MAKING A DIFFERENCE: You **CAN** make a difference by never forgetting the words of Margaret Mead, "Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has." (Rivera & Banbury, 1994)

Name _____

WHERE DO YOU STAND?

Role Play Assignment Sheet



ROLE	VIEWPOINTS
PARENT	**Position 1:** We know how much water we use in our home and make every effort to conserve it. We fix leaky faucets immediately, take short showers, and collect cold water while we're waiting for hot water and recycle it. **Position 2:** There are more important things in life to worry about than how much water we use. No, we don't monitor how much water we use.
FISHERMAN	**Position 1:** I throw out old nets and trash in the water. It's a big lake, no one will ever know. **Position 2:** I do as much as I can to make sure this water is safe for me, my family, and the wildlife that lives in it.
GARDENER	**Position 1:** I get paid good money to keep my client's garden looking good. Although it is not the most environmentally friendly way of watering the lawn, I use a fine mist sprinkler system. It's expensive, but hey, I don't have to pay for it. **Position 2:** People can have beautiful gardens and conserve water. I water my client's grounds before 10:00 a.m. and recommend plants that don't require a lot of water to begin with.
BUILDING CONTRACTOR	**Position 1:** I use as many energy saving products in my buildings as I can. I use water efficient toilets and shower heads in all of the bathrooms. These products not only save money, they also save water. **Position 2:** Since most customers are only concerned with the bottom line and how much money they can save, I don't worry about using energy efficient materials.
AUTO MECHANIC	**Position 1:** It is too time consuming and takes up too much space to recycle used motor oil. I throw it out behind my shop. Nobody knows. **Position 2:** I help protect the water supply by regularly taking the used motor oil I've collected in my holding container to the recycling center.

WHERE DO YOU STAND?
Role Play Assignment Sheet, Page 2

ROLE	VIEWPOINT
MAYOR	**Position 1:** When elected, I promised to do everything I could to help protect the environment and our natural resources. I'll do what I can to have laws passed that protect our water supplies. I fight anyone who is polluting our waterways. **Position 2:** Even though I know that local businesses and industries are polluting our waterways by dumping waste products in them, I can't really do anything about it because I received large campaign contributions from some of the owners.
TEACHER	**Position 1:** I believe teaching water conservation is important. However, it doesn't really fit in with anything I teach and there is always so much material to cover. If there is time at the end of the year, I'll do it then. **Position 2:** I can easily put water conservation issues into my curriculum. I think it is essential that students understand their impact on the environment.

From *Science Scope*, 1994

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CHAPTER FIVE

Summary and Conclusion

Glassboro has been faced with the dilemma of complying with the New Jersey DEP mandate of reducing its reliance on the Potomac-Raritan-Magothy aquifer. Glassboro's proposed solution requires the building of a new water treatment plant that will purify water pumped from the surficial Kirkwood-Cohansey aquifer. Public officials recognize the need to educate the community about local water resources and water conservation practices. At this time, there exists no written curriculum for doing that in the course of the eighth grade Earth Science classes. Therefore, the purpose of this project was to develop a series of enrichment activities dealing with local water resources and water conservation practices to supplement the current Glassboro Eighth Grade Science Curriculum.

Information gathered in preparation of this thesis project was obtained from personal interviews, a regional water conference, various federal, state, and local publications, and library CD ROM systems. This data was then utilized to create the enrichment unit presented in Chapter Four. Each lesson can be easily integrated into the Water Systems subunit of the Geology unit of the Merrill Earth Science text at the average eighth grade skill level. The lessons can be done in the classroom or at a location within walking distance to the school outside of the classroom. Materials for the lessons can be obtained easily and inexpensively. The lessons were developed to promote critical thinking, problem solving and cooperative learning.

The author has come away with many horizon-broadening experiences in completing this project. One is the indepth knowledge gained about local water resources. Another is the motivation to want to protect the area's water resources. Participation in this project has been the impetus for joining the South Jersey Safe and Clean Water Committee and The Federation of Gloucester County Watersheds Association. Yet a third has been added: expertise in creating attractive handouts for students using the computer and CD ROM programs. More importantly, this knowledge and motivation can now be projected to students who come into contact with the Earth Science curriculum and the enrichment unit.

This enrichment unit will definitely be used as a tool for teaching environmental education in the classroom as long as the author is teaching the Earth Science curriculum in Glassboro. It is sincerely hoped that the unit will continue to be used even after the author may be gone from the school system. Even if the author does move on, experience gained in preparing this thesis will make it easy to use a new area's local environment to design and create enrichment units or lessons which can be used to enhance the responsible environmental behavior of the students that participate in them.

Following is a list of suggestions of topics associated with this thesis that could be further researched.

°Adjusting the enrichment unit to varying levels of students; scaling it down for younger students; adding more details for older students.

°Designing similar projects to supplement Earth Science texts in surrounding communities who belong to the Mantua Creek watershed.

°Designing other supplemental units which might explore other environmental issues within the community of Glassboro.

°Studies of water quality and usage once pumping from the Kirkwood-Cohansey aquifer and water treatment has begun.

°Studies of health problems associated with water pollution and water contamination.

°Studies of the effect of pesticides and herbicides on surficial aquifers.

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