# The Natural World We Take for Granted

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## INTRODUCTION

Children are self-centered. You can't blame them; they simply don't know any better. Their "out-of-sight, out-of-mind" philosophy applies perfectly to their lack of understanding about actions causing reactions. I was unknowingly guilty of this very thing myself for years and years. I can recall a time when I was 10 or 11 years old and my teacher taught a lesson about recycling plastic and the effects that recyclable materials had on landfills. Up until that point, I had simply tossed everything into the trashcan, assuming it would be whisked away to some magical place that would not take up space, pollute the earth, or otherwise cause problems. This new awareness that a magical landfill did not exist empowered me to immediately put a stop to the horrid and unnecessary trash my family was contributing to our beautiful planet! I rushed home, opened the refrigerator, grabbed all of the plastic containers I could find, and examined each one to make sure it was recyclable. If a container was not accepted at our local recycling plant, I would shout to my mother (who was across the house and probably becoming very annoyed with me), "I found another bad one!" or "Don't buy this butter next time we go to the store!" Little did I realize that during my crusade, I had been opening and closing the refrigerator over and over again, wasting another natural resource and running up our energy bill!

I consider myself very lucky to have been raised in a loving and stable family that made sure to teach me how to be a responsible kid. Yet, rarely did my parents discuss what it meant when I left the water running the entire time I brushed my teeth, or when I left the front door open and started "air conditioning the front porch." Awareness and preservation of earth's natural surroundings and resources is usually at the bottom of a very long list of parental duties. When I consider the population of children I teach right now, I know their parents either do not have the time and/or the knowledge to educate them about Mother Earth. Typically, these families consist of a single parent with little or no formal education, who is raising and supporting at least three young children. The parent frequently works two jobs and/or is busy tending to the younger child(ren), so there is hardly time to inquire about her older child's day, much less check homework or have a conversation about why candy wrappers should not be thrown on the ground when walking home from school. The children I teach come to me with a semi-inquisitive interest in their surroundings. Through exposure from past field trips, science lessons, media reports, books, and the Internet, they have a vague sense of how external factors can change an entire ecosystem. To me, general acknowledgment of littering and oil spills is not sufficient. I want to turn this tepid curiosity and indifferent interest into a thorough understanding that they are not isolated beings that can come and leave a mess behind for others to support.

## UNIT BACKGROUND

Through this one- to two-week unit, the children will study the ill effects of air and water pollution, making the major focus their neighborhood and the minor focuses on Houston and Texas. Their first step is to observe air pollution in its "natural" state by determining areas of high pollution while traveling to and from school. We will then investigate water pollution via water testing and observation. Finally, we will focus on the conservation aspect of these micro-environments through neighborhood clean-ups, interviews with community members and/or parents, and suggestions for future reduction in pollution problems.

Throughout this unit, I will show my children that they have the power to preserve the earth throughout their lives either by personal action or career decision. I have overheard some of my children say that they do not care about academia because they are going to work in their father's mechanic shop or assist their mother with cleaning houses. I want to empower them with the idea that they have the potential to do anything and *can* make a difference; they have a *choice* to have a job or career that can exist outside of their parents' footsteps. Once I can convince them to care enough about their environment, this passion will hopefully spread to other aspects of their lives, including current grades and future dreams.

## IMPLEMENTATION STRATEGIES

The beginning of the unit will start with questions such as, "What is conservation? What is pollution? What causes pollution?" We will have a discussion of the children's observations regarding pollution around their neighborhoods, as well as what they have done to this point to be conservative. I will ask them to share thoughts with us about what we could do as a class to be conservative.

We will begin with neighborhood observations of specific places, including storm water marshes (areas near street gutters where rain runoff has collected and mixed with street garbage and plant debris), brush piles, construction sites, and other miscellaneous areas where humans have altered the natural environment. The children will bring a lab notebook and record the date and a brief description of the site, including the area's size, presence of flora and fauna, and opinions regarding human alteration of the site. In addition, they will draw two pictures: the first will show what is present now and the second will require their imagination. They will create a vision of the site that existed before human intervention. Once this is completed, they will recommend how their site can be improved or protected.

The next step in our unit will be to discuss various areas in the community we can assist in becoming more environmentally friendly. During this discussion, I will impress upon my students that pollutants exist even though they cannot be seen. To prove this to them, I will have them conduct their own solid waste and air pollution tests along the routes they take home every day from school. Because of these tests, the children should

correlate that high-traffic streets will have higher levels of pollution. For example, the children would be asked to keep pollution journals observing the number of cans, paper, and other similar "roadside trash" they see each day. The next week in class, we would tally and graph the totals, and bring in representative examples of each item to figure out how much the waste weighed. This will give the children an estimate mass of the trash they pass by every day. Another example would be to smear Vaseline on a white index card and observe the discoloration or debris caught each day. Done in 5 consecutive days, the children should see consistent levels of pollution in a particular vicinity. An extension would be to repeat the test in a different area the next week. Furthermore, if time or travel permits, the children could take a field trip to other sites around the city that have varying levels of air and solid waste pollution, from the ship channel to the suburbs of Katy. During all these tests, the children will be keeping a journal to reflect how they could reduce the amount of pollution in their neighborhood. Some examples of this would be neighborhood clean-ups, carpooling, or planting trees.

Water testing on our creek behind the school is a great way to witness the effects of pollution. We had been water testing our classroom aquarium for nitrite and nitrate levels as a result of the organic waste from the creatures inside of it in order to demonstrate the nitrogen cycle. I want to make a connection that the nitrogen cycle also exists in the water cycle; furthermore, our creek is a part of the overall water cycle. Eventually, we will be drinking that water. Their disbelief can be diminished with a trip to a local wastewater treatment plant. They will see that pollutants put in the water will eventually end up in their own bodies. This will lead into water testing at our creek for things such as microorganisms, disinfectants, and inorganic chemicals. As a result of these water tests and viewing the microorganisms under a microscope, they will learn that putting human and animal waste into water can cause very negative side effects. As an extension of this unit section, the children can take water tests from multiple sources and observe the number and general health of creatures living in each sample of water. They will learn that the creatures living highly toxic water contain larger amounts of toxins in their tissue and are therefore unhealthy to eat.

Once we have explored various areas and gathered enough information, the class will focus on one particular location and discover what is causing its pollution. The children will invent ways to improve this site in the form of community service and/or neighborhood awareness programs. I plan on incorporating a science journal so the students can record observations, data, and thoughts about what we are studying. This journal will be used as a reference tool throughout the students' investigations. A cross-integration could include a social studies component studying past environmental movements across the country or the history of Earth Day or Arbor Day.

## OVERVIEW OF AIR AND WATER POLLUTION IN THE UNITED STATES AND TEXAS

With the purpose of supplying the reasoning behind the lessons, I have included current facts and information concerning the causes and preventatives of air and water pollution.

State and national laws have also been mentioned that support reduction or elimination of certain pollutants. In order to teach this unit, these facts will be of utmost importance and should not be overlooked. The students will correlate their small experiments with a larger-scale global impact. They must be able to understand that pollution is a well-known, long-term, not-easily-solved problem. It will take a team effort among lawmakers, businesses, and ordinary citizens, along with a lot of money, in order for even a dent to be made.

**Air Pollution**

Air pollution in the United States has only recently been brought to the attention of the public. In 1948, a small industrial town called Donora (in Pennsylvania, just south of Pittsburgh) experienced a meteorological phenomenon known as an inversion. A toxic cloud made of sulfur dioxide, carbon monoxide, and metal dust killed twenty residents and hospitalized approximately 7,000 more as a result of inhaling the gaseous and solid waste. The local zinc smelter, in which most of the town residents worked, was the culprit (McCabe). It was almost fifteen years later that the first federal legislation concerning the quality of air was passed. However, 1965 was the first year in which air quality acts were created. The National Clean Air Act of 1965 established air quality control regions for each state; Texas has twelve. Each regional office in Texas, collectively called the Texas Air Control Board (TACB), is responsible for monitoring and reporting air quality throughout the year. For example, between 1993 and 1995, the number of days per year that the Houston area exceeded harmful ozone levels jumped from 13.7 to 22.2. This jump was attributed to the increase in the number of drivers on the road and the concentrated amount of refineries in the area (Stewart 5). In addition to monitoring, the offices receive complaints (most of which are against public or private businesses who release gases into the air), and maintain communication among city, county, and federal governments (Stewart 9). The National Clean Air Act of 1977 requires local governments to plan for a more environmentally friendly transportation system. This requirement caused the TACB to study future effects of high sulfur content in gasoline as well as the improved design and performance of vehicles (10).

This preamble leads to the question of, "Where does air pollution come from?" The number one source of air pollution in Texas is from combustion in machines releasing carbon monoxide (CO). Car exhaust is the primary source of CO, although refineries that burn coal, oil, or natural gas release it as well ("Air Monitoring Report," TNRCC 15). As population increases, the number of cars on the road increases, thus potentially creating more carbon monoxide. Some ill effects of CO include headaches or loss of detailed vision. Prolonged exposure to CO also blocks oxygen to the brain, and in sufficient concentrations is toxic. Additional pollutants found in all burning fuels are Nitrogen Oxides such as Nitric Oxide (NO) and Nitrogen Dioxide ($NO_2$), and Hydrocarbons (HC), which cause the brownish smoggy haze that is visible over the Houston skyline during hazy or windless days. Hydrocarbons and oxides of nitrogen in the presence of sunlight

react to form Ozone ($O_3$). On particularly poor days the newscaster on TV tells you it is an "Ozone Action Day" (Stewart 14).

Another main source of air pollution is particulates, which are solid or liquid pieces of matter that can range from dirt to smoke (Stewart 28). The source of most particulates is again from combustion, in the case of automobiles from the combustion of gasoline. Additionally, agricultural machinery can create particulates when they stir up dirt, and natural occurrences such as wildfires or volcanic eruptions produce particulates when ash is released into the air. Particulates can coat buildings and people with thin layers of grime and can cause lung problems when inhaled. Additionally, particulates serve as vectors for toxic chemicals to enter deep into the lungs. Other kinds of air pollution include lead, asbestos, and arsenic (Stewart 29).

What harm can air pollution do? At the simplest level, it can make you sick. Respiratory problems including bronchitis, emphysema, asthma, and some lung cancers are caused by air pollution (Hart 1). It even worsens the effects of the common cold! Children and senior citizens are especially at risk. Air pollution also causes the high-altitude Ozone layer to thin out as a result of chemical pollutants "eating" the Ozone away. Without this protective layer, Earth as we know it would be uninhabitable because of the extreme rise in the intensity of ultraviolet (UV) rays of the sun hitting us. An increase in UV sunlight would create an increase in skin cancers and kill flora and fauna that are not adapted to such light (Stewart 53).

What are the United States and Texas doing to combat air pollution? In addition to Federal Acts for cleaner air, the Environmental Protection Agency was formed in 1971 through the merging of existing agencies to regulate national levels of clean air. They have set strict emission standards in order to limit the amount of pollutants a particular business or machine may emit during a given period of time. They also lobby Congress in order to pass additional laws restricting, or even prohibiting, certain chemicals from being released or manufactured ("Air Monitoring Report," TNRCC 12).

In Texas, the TACB developed objectives that continue to guide them in fighting for cleaner air. These include assisting enforcement of the Texas Clean Air Act (TCAA) or making predictions concerning metropolitan growth in order to preserve air quality. The TCAB also regularly submits emission reduction plans and air pollutant levels to the EPA. These agencies perform endless investigations and spend limited amounts of federal and state monies in order to continue the fight for cleaner air ("Air Monitoring Report," TNRCC 19).

On the local level, Houston practices its Ozone Action Days, warning residents to limit use of their vehicles or other gas-powered machinery during peak hours. Additionally, the media discourages us from being outside for prolonged periods of time, especially for those who have sensitivity to sunlight.

Even though there are numerous groups and individuals pushing for healthy air, it is simply not enough. The trickle-down effect has reached the children in my classroom, who already seem apathetic towards most everything except the present anyway. Their fervor needs to be sparked!

**Water Pollution**

Water pollution is not a newfound problem. Before running water and the Industrial Revolution in the 1800s, most people lived in small village communities and collected water in small amounts as needed. When people started gathering together to form towns and build factories, they learned that running water was essential for powering and cleaning the machines. Consequently, rivers and lakes were the endpoints of factory waste. Additionally, because of such dense populations, sewage systems were built to channel human waste into bodies of water instead of being dumped into the street. While this dramatically improved sanitary conditions and lowered the spread of epidemics and disease, the sudden rush of organic pollution choked the flow of water and produced quite a stench as well (Best 4). Complaints from the locals and subsequent water tests forced city officials to begin building water treatment plants and treating the water with chlorine to kill bacteria such as coliform, typhoid, and cholera (Perry 65). However, no sewage system is perfect, and most are extremely under-funded or in dire need of updating. Consequently, virtually all rivers in the United States today are still unsafe to drink directly from (68).

The most common form of water pollution is industrial and domestic waste. The industrial waste component mainly consists of traces of heavy metals such as copper, zinc, iron, and lead. However, many small and frequent accidents add to the problem. Examples include chemical spills, pipes breaking, and runoff from nearby pesticide spraying (Perry 73).

There are varying degrees of what is considered acceptable water, depending on its purpose. For industries that use water for power or cleaning, the Federal Water Pollution Control Administration set quality standards for each state. In Texas, for example, it is required that radioactive levels cannot be increased due to industrial waste. Also, the water must not have any free-floating solids (Nemerow 212). There are also classes that water is categorized into and each class has its own standards. For example, class AA, which is used for drinking or food processing, has narrower ranges of acceptable pH levels, temperature, or sewage effluents than class D, which is used for agricultural and industrial purposes. All classes still have to remain suitable for fish survival (220).

Interestingly though, most big city water systems have no laboratories or technicians to detect chemical pollution. Houston, however, does. Wastewater operators have a dedicated lab specifically designed for this type of pollution, in order to comply with permit regulations. The Department of Health and Human Services also monitors the bayous monthly and does random spot checks in addition. But the cost for immediate

water testing is too great for even most cities to afford, especially if the chemical change is sudden. Although water samples are taken randomly as the law requires, the results take weeks to come back. Even if there were a way to test the water quickly after accidental spills, treatment plants do not have the equipment necessary to remove the chemical contaminant (Perry 74). Therefore, the only quick indicators used are sentinel species; the most common are fish. Experts and novices alike can swiftly tell there is an increase in water pollution if the fish are all belly-up! But even this detection tool has its drawbacks. Colder weather makes fish more resistant to pollutants because of their decreased rate of respiration. Also, if fish are slowly killed off instead of an instant high death rate, the pollution may go completely unnoticed (Nemerow 226).

Most people know that water pollution can make you sick. A widespread belief is that drinking water is the most likely culprit. However, the odds of someone drinking contaminated water are quite small because of its chlorination in a water treatment plant (unless there is an accidental chemical spill or unknown leakage of a chemical, as mentioned above). The most probable way to get ill is through public bathing or swimming waters that are not chlorinated. Some illnesses include infections of open bodily cavities (eyes, ears, etc.), skin diseases such as ringworm or eczema, gastrointestinal disorders, hepatitis A, and typhoid (Nemerow 222).

What is being done to thwart water pollution? Besides legal restrictions and standards, research groups and environmental activists are struggling to find cleaner alternatives for industrial clean-up and power usage. Most new industries have included pollution reduction in their design. Agriculturalists are increasingly using human and animal excrement for fertilizer or mulch. Organic waste-carrying runoff is beginning to be piped to farmlands and spread over the land (Perry 94).

I find it interesting and somewhat alarming now that people in developed countries take such advantage of clean drinking water pouring from their faucets any time they please. The separation of source and consumer since the Industrial Revolution has caused industries and individuals alike to abuse this natural and widely available resource to the point of toxicity. Heightened awareness and responsibility, as well as efficient funding, is essential to curb any further destruction of our water.

## CONCLUSION

The following lesson plans will unite the earlier facts mentioned with hands-on experiments so that the children will discover real-life pollution in their neighborhoods and school grounds. Through my teaching experience, and especially concerning the population of children I work with, hands-on learning is by far the most successful form of curriculum for them to comprehend and later recall. Making learning authentic also adds value to the program of study. I have chosen to include lesson plans that are realistic and which take place in or around their own neighborhoods. The students will realize that pollution is not some intangible notion mentioned in their science books; it is

a living problem that continues to grow. In addition to the five lesson plans I have included, you may want to refer back to the Implementation section of this unit to incorporate a more holistic approach in teaching this topic. Field trips to local bodies of water, water treatment plants, or even downtown Houston would be an added reality connection.

The first lesson plan I wrote concerns a nature walk. This basically gets the children thinking about the trash they might not have thought twice about, much less noticed, the day before. It also allows them to practice simple observation and recording of data, using descriptions, pictures, patience, and imagination.

The next lesson plan discusses water pollution and how it is connected to the water cycle. The children will test ponds, creeks, or even standing puddles after a rainstorm, for chemicals or unusual pH levels. To prove the connection to the water cycle, teachers can point out that puddles evaporate, creek levels rise and fall, and ponds sometimes dry up. This can be proven with simple observation or measurement of the water source's height. Over the course of a month, they will graph the pollutant levels from the water tests and predict the source(s) of the contaminants. Water levels or presence and number of puddles could also be graphed.

Two lesson plans I have integrated will introduce and explain the idea that not all pollutants are visible; the first will talk about invisible air pollutants and the second will discuss invisible water impurities. Students will test air around school over the course of a week and graph their results. Tasting water samples that have diluted amounts of sugar, salt, vinegar, and citric acid will prove that clear water does not always mean clean water. The children will be able to deduce that air and water pollution is happening right under their noses and they most likely cannot even see it.

Another lesson plan contains an extension of the notion of invisible water pollution and its effects on plant life. The students will contaminate water with vinegar and study the reaction of a plant over the course of a week or two. Children could do observation journals of outdoor plants after it rains and include water testing of puddles or streams before and after a rainstorm as an extension.

The last lesson plan shows children how to calculate how much they are contributing to air pollution simply by throwing away trash, using cars or public transportation, or even switching on a light in their room. Formulas are provided so that the children can easily convert time and money into pounds of pollution.

The ultimate goal of this curriculum unit is for the children to walk away feeling a sense of vigor and an intrinsic motivation to think about how their actions cause reactions in all aspects of life. Further, I hope they will want to share this newfound passion with people around them. It would be ideal if I can hear a story from one of my students telling me how she stopped her father from dumping his motor oil down the gutter, or

how she convinced her brother not to keep the water running while brushing his teeth. Who knows; maybe Dad or Brother will spread the word.

## LESSON PLANS

### Lesson Plan One: Nature Walk

***Purpose***
To observe a local community's ecosystem and detect presence of air or water pollution.

***Grade Level***
$4^{th}$ – $6^{th}$ grade

***Objective***
The learner will walk around areas in their neighborhood and observe normally suspicious areas such as street corners, storm water marshes, and construction sites for evidence of pollution. The learner will keep a journal of experimental procedures, results, and conclusions.

***Introduction***
Ask the students if they believe their neighborhood is polluted, including where and how they know. Note responses on the board. Ask the children if they know what conservation means. Provide the root word 'conserve' if necessary. Ask them what they have done to this point to be conservative.

***Materials***
- Lab notebook
- Pencil

***Procedure***
1. Walk with the children around the school campus, or ask permission to take a miniature field trip around the neighborhood.
2. Point out observations of specific places, including storm water marshes (areas near street gutters where rain runoff has collected and mixed with street garbage and plant debris), brush piles, construction sites, and other miscellaneous areas where humans have altered the natural environment.
3. The children will bring a lab notebook and record the date and a brief description of the site, including area's size, presence of flora and fauna, and opinions regarding human alteration of the site.
4. They will draw two pictures: the first will show what is present now and the second will be their version of the site that existed before human intervention.
5. Gather for a group discussion and share how their site can be improved or protected. Also brainstorm about what the class could do to be conservative.

***Enrichment***
Focus on one particular location and discover what is causing its pollution. The children will invent ways to improve this site in the form of community service and/or neighborhood awareness programs.

**Lesson Plan Two: Testing, Testing**

***Purpose***
To prove that water pollution can be harmful to your health.

***Grade Level***
$4^{th}$ – $6^{th}$ grade

***Objective***
The children will discover that their own careless actions concerning water can come back to harm them via the water cycle.

***Introduction***
Create a KWL chart about the water cycle. If not mentioned, ask the children if they think water pollution is a factor. Bring up the fact that nearby bodies of water, such as Clear Lake to Buffalo Bayou, in addition to water halfway around the world, are all connected into the grand scheme of the water cycle. A body of water anywhere in the world will eventually be consumed by them because of this, so pollution plays an extremely important role.

***Materials***
- Water testing kit (www.watersafetestkits.com)
- 4 or 5 Microscopes
- Plastic slides
- Lab notebook and pencil

***Procedure***
1. Take the students to a nearby body of water. A creek, pond, or even the ocean will do. If no water source is available, testing the drinking water at school will produce similar conclusions.
2. Perform the water tests according to the instructions that accompanied them.
3. Record levels of chemicals, organic waste, and pH on a chart.
4. Repeat water test once a week for a month, and preferably after a rainstorm. Note changes in the various pollutants. Discuss why certain levels went up.
5. Take a drop of water you are sampling and view it under a high-powered microscope. Note any contaminants. Have the students draw a picture of what they see and predict the source of these impurities.

***Enrichment***

- Take water tests from multiple sources and observe the number and general health of creatures living in each sample of water. They will learn that the creatures living highly toxic water contain larger amounts of toxins in their tissue and are therefore unhealthy to eat.
- Take a trip to a local wastewater treatment plant, connecting the idea that putting pollutants in the water will eventually end up in their own bodies.

**Lesson Plan Three—Pollution: Visible and Invisible**

***Acknowledgment***

This lesson plan was adapted with permission from Maclyn Jones a professor at Texas Southern University in Houston. The lesson came from her 1995 TES Course and can be viewed at <http://www.tnrcc.state.tx.us/air/monops/lessons/visiblelesson.html>.

***Purpose***

To try and tell the difference between visible and invisible air pollution.

***Grade Level***

$4^{th}$ - $6^{th}$ grade

***Objective***

The learner will test for visible and invisible pollutants in the air. The learner will keep a journal of experimental procedures, results, and conclusions.

***Introduction***

Ask each student, "What is air pollution?" Write all ideas on the board. Through discussion, arrive at one definition. Divide students into groups to brainstorm things that pollute the air. Have groups take turns recording ideas on an air pollution chart posted in the room. (Repeat this introduction for the invisible pollutants experiment as well, except replace the word "air" with "water.")

***Materials***

- chart paper
- measuring cups

*For each group you will need*

- white index card
- petroleum jelly
- 3 bean plants, approximately the same size
- tap water
- vinegar
- vinegar-water mixture in 1 to 3 ratio

- pH paper or indicator

***Visible Pollutants Experiment***

1. Divide the ideas from the air pollution chart into two groups of pollutants: visible and invisible.
2. Smear petroleum jelly on the index card.
3. Decide on several places around the school where students think visible pollutants will occur. Each group should have a different area to test. Make predictions about which area will have more visible pollutants and why. Record predictions in a journal.
4. Place cards in test areas for several days. Have the groups check the cards daily. Record observations in a journal.
5. Bring cards to class for comparison. Observe and rank the cards from the one with the most visible pollutants to the one with the least. Assign each card a number. Discuss why certain areas have more visible pollutants than others.
6. Mark a school map showing the ranking of areas from #5. Display the map in the hall for others to see. Predict why some cards had more pollutants than others. Record in observation a journal.

***Invisible Pollutants Experiment***

1. Define pH using a dictionary or science book. Discuss what different levels of pH mean.
2. Divide the class into three or four groups. Each group sets up a bean plant garden with three containers, each container having one bean plant each.
3. Students determine and compare the pH of the tap water, vinegar, and vinegar/water solutions using pH paper. They will predict how the plants will be affected by each solution. Record pH and predictions in a journal.
4. Plants will be watered every day with 1/8 to 1/4 cup of a solution: one plant with tap water, one plant with straight vinegar, and one plant with the vinegar/water solution. Procedure is recorded in journal.
5. Observe plants daily. Record in a journal what happens to each plant. Sketches may be part of the observations.
6. Compare plants and discuss observations at the end of a day, week, two weeks, or until plants die.
7. Using the observations of all groups, write a class conclusion for this experiment. Record in a journal.
8. Arrive at the idea that the invisible pollutants experiment was about acid rain, caused by water pollution.

***Enrichment***

- Research the history of acid rain. Include information on the causes of acid rain, when we first became aware of the problem, what problems have been caused by acid rain, what measures have been taken to combat acid rain. Has the situation improved?
- Make a class mural to show the acid rain cycle.

- Post a chart for the causes of visible pollutants and what can be done to prevent them. Leave the chart up so students can add to it whenever they have an idea.

**Lesson Plan Four: Invisible Pollutants - Part II**

***Acknowledgment***

This lesson plan was adapted with permission from David A. Gilliam, a teacher at Susitna Elementary School in Anchorage, AK. His lesson plan was made available through Academy Curricular Exchange - Columbia Education Center and can be viewed at <http://ofcn.org/cyber.serv/academy/ace/sci/cecsci/cecsci026.html>.

***Purpose***

To help students understand that clear water isn't necessarily free of pollutants

***Grade Level***

$4^{th}$ - $6^{th}$ grade

***Objective***

The student will taste different water samples to conclude that not all pollutants are visible. The learner will keep a journal of experimental procedures, results, and conclusions.

***Introduction***

The teacher will remind the children of their previous experiment with invisible water pollutants. Ask the children, "Do you think that clear water is always free of pollutants?" Ask for explanations, or have them predict in their observation journals.

Safety note: Tell the students that there is more than one way to test for water pollutants. However, the safest way is through water testing kits. Remind the children to NEVER taste water from unknown sources.

***Materials***

- 5 cotton swabs or spoons for each student
- 5 cups of tap water
- 1 tbl sugar
- 1 tbl white vinegar
- 1 tbl salt
- 1 tbl citric acid

***Procedure***

1. Place one tablespoon of a substance into one cup of water and mix thoroughly until dissolved completely. Repeat for the other substances until you have 5 cups of water, 4 of which contain a substance.

2. Using cotton swabs or spoons, have students taste each liquid (dispose of swab or spoon after each taste) and record what they taste after each.
3. After students have all had a chance to taste, discuss that some kinds of pollution can't be seen.

***Enrichment***
- If you have local creeks, streams, or other waterways that are unsafe for human use, this is a good jumping off point to discuss the problems these bodies of water have.
- If there is a nearby natural water source or if it has just rained, take water samples and test pH levels or traces of heavy metals.

**Lesson Plan Five: We're Changing the Atmosphere**

***Acknowledgment***
This lesson was used with permission from The Franklin Institute Online. Their information and original lesson plan can be viewed at <http://sln.fi.edu/tfi/activity/space/sp-1.html>.

***Purpose***
To examine the effects of global warming and how humans contribute to it.

***Grade Level***
4th -6th grade

***Objective***
The students will connect individual behavior to a global issue and increase understanding of ways to reduce the greenhouse effect.

***Introduction***
Although students may understand the cause and effects of global warming due to the greenhouse effect, many may not establish the connection between their own behavior and its impact. By keeping a "CO2 Journal," each student establishes this connection, while simultaneously discovering what he or she can do to reduce global warming.

***Materials***
- copies of worksheet (one per student).
- reading from a home electricity bill
- odometer reading from a bus or car (can also use estimated distance from a map)

***Procedure***
1. Determine a period of time (about one week) over which the students will measure their CO2 production.
2. During the sample time, students should record their daily transportation, home energy, and waste behaviors.

3. Totals for the week are entered on the worksheet.
4. Students should calculate an estimate of their direct carbon dioxide emissions. (This is only an estimate; the formulas assume that all members of the household are using energy equally, that production of the electricity uses an average ratio of fossil fuels to nuclear and renewable sources, etc.)
5. Total the emissions from different sources to get a weekly estimate.
6. Multiply the weekly estimate by 52 to find the amount of CO2 produced in a year.
7. Multiply the annual total by two to reflect indirect production of carbon dioxide. These indirect emissions include everything from the energy needed to make their pencils to the fuel used to bring groceries to the supermarket. (Typically, ones indirect production of CO2 is roughly equal to ones direct production.)
8. Student totals will be above the global average of 9000 lbs of CO2 per person per year.

***Enrichment***

- Many experts think that stabilizing the climate may require a 50% reduction in global emissions of CO2. By examining the worksheet, students should be able to find ways to cut down: finding more efficient ways to get around; using less electricity, gas, and oil; and recycling more.
- Ask the students to aim for a 20% reduction in their emissions, and have them figure out what steps they could take to meet that goal.
- Students may graph their CO2 production by source.
- Determine what effects renewable energy sources such as solar and hydroelectric power would have on CO2 production.

***Transportation***

*By Car*
a) Miles travelled during the week: _____
b) Miles per gallon of that car: _____
c) Gallons of gasoline used (a/b): _____x 22 lbs/gal = _____ lbs CO2

*By Bus*
a) Miles travelled during the week: _____x 0.7 lbs/mile= _____ lbs CO2

***Home Energy –*** check your family's utility bills

*Electricity*
a) Kilowatt-hours of electricity used in a month: _____
b) kWh used in a week (a/4): _____
c) kWh used per person (b/# of people in household): _____x 1.5 lbs/kWh = _____ lbs CO2

*Natural Gas*
a) Hundreds of cubic feet of gas (ccf or therms) used in a month: _____
b) Therms used in a week (a/4): _____
c) Therms used per person (b/# of people in household): _____x 11 lbs/therm = _____ lbs CO2

*Waste*
a) Pounds of trash thrown away: _____x 3 lbs/lb = _____ lbs CO2
b) Pounds of trash recycled: _____x 2 lbs/lb =_____ lbs CO2

**==========TOTALS==========**
**(Global Average = 9000 lbs/person/year)**

a) Total of daily direct CO2 emissions: _____ lbs
b) a x 365 = Total annual direct CO2 emissions: _____lbs
c) b x 2 = Total annual CO2 emissions: _____lbs

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### Teacher Resources

Council for Environmental Education (Project Wild). *Taking Action: An Educator's Guide to Involving Students in Environmental Action Projects.* Project WILD National Office. 5555 Morningside Drive, Suite 212 Houston, TX 77005 (713) 520-1936

*Do You Know How to Keep Our Water Clean?* Austin: Texas Natural Resource Conservation Commission Oct 2003.
A mini-workbook discussing causes of water pollution and how to clean it up. Includes reproducibles.

"Ecology." Heath: Middle Level Literature. *Education Place.* Houghton Mifflin, 1997. <http://www.eduplace.com/rdg/hmll/blue/ecology/index.html>
Provides a guide on how to help children begin natural area observations.

*The Health of Galveston Bay Seafood*. Galveston Bay Estuary Program. <http://www.gbep.tamug.tamu.edu/ss.seafood_home.html>
A map showing the contaminated areas of Galveston Bay and where it is safe to fish for food.

*List of Drinking Water Contaminants & MCLs*. US EPA 27 Feb. 2004. <http://www.epa.gov/odwdw/mcl.html>
A comprehensive and detailed list of the numerous contaminants found in common drinking water, as well as their ill effects on environment and people.

Roberts, Janet W. and Carole Huelbig. *City Kids and City Critters! Activities for Urban Explorers*. New York: McGraw-Hill, 1996.
An activity book aimed on making children aware of the urban creatures that live among them. Allows observation, experimentation, and surveying of local environments in order to better understand why certain creatures choose to live in particular municipal areas and behave in specific ways.

*Teacher's Glossary on Air Pollution*. Austin: Texas Air Control Board, 1982.
A complete list of all words and their definitions related to air pollution.

*Teacher's Guide to Air Resources in Texas*. Austin: Texas Air Control Board, 1982.
A brief review of air pollution causes and effects with actual lesson plans.

*Teacher's Handbook on Air Pollution*. Austin: Texas Air Control Board, 1984.
Similar to the aforementioned source, with some games and puzzles to reproduce.

*Water Test Kits for Elementary and Middle School Kids*. 1998-2004. Science Fair Center. <http://www.sciencefaircenter.com>
A site dedicated to ideas for science fair projects. Included is a page where you can order different water testing kits, depending on which chemical you are looking for.

*Water Treatment Cycle*. 2002. US EPA. 2002. <http://www.epa.gov/OGWDW/kids/treat.html>
A great visual for kids to see the path of a raindrop from a cloud in the sky to a faucet in your house.