Chapter 4

Inquiring About the Environment: A Service Learning Project

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Introduction

One of the major challenges faced in teaching a nonmajors science class is to make a connection to the social environment affected by science (although this can be argued for a majors class as well). Many students view science as a very formal process that occurs in a sterile lab. This project was designed to show that environmental testing can occur in many locations and can provide a community service in less fortunate communities. The study of urban gardening can help students in introductory science classes with a diverse range of interests learn about the scientific process.

This project combines extended inquiry with service learning. Participants will use basic soil sampling techniques to do a site analysis. They will provide a report to the community partner on the suitability of the site for its intended purpose.

Notes for the Instructor

Service Learning

Putting content in context is one of the best ways to help students learn. Having a goal that serves a useful function in the community provides both meaning and context. Students working towards a goal have a need to learn and are therefore more motivated to learn. We have created a special variation of our general education environmental science course that incorporates service learning. The course provides a framework for students to learn and practice inquiry. In both the standard and the service sections, students spend the first half of the semester learning science practice and basic concepts such as population, survivorship, and biodiversity. They do this in a format where they also learn to ask scientific questions, formulate hypotheses, design experiments, collect and analyze data, and present conclusions. The assessment tools have been constructed to evaluate both content and process skills and include a reflective component. During the second half of the semester, students in the standard sections learn techniques for determining environmental quality and then apply those techniques and others learned during the semester to answer a question (that they generate on their own) about a site. This group work occurs over six weeks. Students in the service section focus on a plot of land intended for community gardens or park development. They learn many of the same concepts and techniques as well as many other things necessary to understand the site and provide useful information to the community.

Finding a community partner

To implement real service-learning, there must be a real need in the community. Furthermore, it needs to be a situation where the students can see how their work will address this need. Our intent is to scale this project to work for multiple sections and to be taught by teaching assistants. For this reason, we have selected a simple site evaluation rather than unique and potentially more complex problems. For this reason we look for sites that are going to be developed as organic gardens or parks. Local schools and parks boards are often looking for assistance in this sort of project. Community organizations, botanical gardens, outdoor education facilities, and environmental activists may also have ties to similar projects.

Identification of the site should begin well before the start of the semester. Have a backup plan of a plot of land on campus. The selection of a site requires knowledge of the community and/or ties with many community members. We have worked with a private landowner who buys abandoned inner city lots and converts them into organic gardens. We have tried to work through a Family Community Center and a teacher at an elementary school. We have worked with a local park naturalist who was able to identify several areas of need. It is easiest to work with some person, agency or group who is already involved in the development or restoration of land for community purposes. Under these circumstances, the land use has already been determined, and getting permission to map and sample on the site is straightforward. Local politics can play a significant role and can delay permission. Check with all of the entities that may have jurisdiction or an interest in the land.

Arrange for someone associated with the development of the site to meet with the students early in the process to describe the use, questions, and possible problems associated with the site project. When working with large numbers of students arrange for one student or group of students to interact with the responsible person. It will be their job to pool questions from the class and communicate answers. This is an essential step if you are working with large numbers of students. It limits the time commitment on the part of your community partner. They do not have to repeatedly answer the same question and they are more likely to continue collaborating in the future. You may also find that it is useful for the instructor to take on this role.

Transportation

When you choose your site, you need to consider how you will get your students to the site. Check with your institution for rules governing off-campus trips. Make reservations for transportation as soon as you have dates and places identified. Check close to the time of the lab to make sure that your reservations are still on the books. Check to see if you need to submit names for insurance purposes. Include travel time in all activities.

Materials

Material needs will depend upon the site you select and the needs of your community partner.

- **Site map**. Topographical maps are available from the USGS and can often be found in better bookstores and wilderness shops. Aerial photos are available for a fee from many internet sites; *http://Terraserver.com* is the one I prefer. Check with your county commissioners or planning office or park system to see if they already have maps you can use.

- **Labeling equipment.** Multiple visits to the site may require careful marking of sampling areas or sampling sites. Flagging tape is available through supply houses, at your local home do-it-yourself store, or hardware store. Old colorful T-shirts or shower curtains can be torn into strips for the same purpose. Wooden stakes can be purchased locally as well. You may also use Popsicle sticks, wooden applicator sticks, bamboo skewers and large nails. Forestry Supply has an extensive variety of permanent labeling items for specialized purposes if you have a need to permanently label an area. You need to make sure that your labels are durable enough to last through the study period. You also need to make sure that they can be removed without damage when the project is finished. Unless there is a valid reason for permanent markings, please make sure that you include time in your plan to remove any and all labeling materials from the site.

- **Sampling equipment.** This can be as simple as plastic spoons and Popsicle sticks. Garden trowels are effective but care needs to be taken to avoid doing serious damage at the site. Soil coring equipment is available from Forestry Supply and most standard science materials catalogs.

- **Soil sample containers.** Special plastic bags with areas from writing collection data are available for purchase. Plastic zipper bags, recycled jars, or disposable food storage containers are equally effective, readily available, and inexpensive. If the sample is to be used in a berlese funnel apparatus to check for invertebrates, then proper aeration is required. (Funnel is described in student handout below.) Samples to be tested for moisture at a later date need to be sealed.

- **Soil test kits.** We use standard soil and water test kits available Produced by LaMotte. Some simple tests are described below. Test strips and home test kits are available at hardware and garden shops. PH papers are available through most biological supply houses. Some examples of test kits we have used are listed below. They are available from most supply houses. Garden test strips and kits are useful because these are simple and students are likely to encounter them in the future.
    - LaMotte Topsoil Tour Kit (RG-3185 Carolina)
    - Lab-Aids Biology and Chemistry of Soil kit (RG-65-3211 Carolina)
    - NPK Soil Test Kit (15580546 Frey)
    - Low Cost Soil pH Test Kit (15586368 Frey)
    - Lead in Soil (RG-18-1805 Carolina)
    - Rapitest Soil Test Kit (15579140 Frey)

- **Meters.** pH and soil moisture meters are available through most supply houses. They vary in quality. You should purchase the best quality you can maintain in your own circumstances. Lower cost usually represents lower reliability. We use inexpensive ones that are easy to replace.

- Other materials that may be of utility include:

Petri plates or sample dishes	String
Probes	Measuring tapes
Water source	Compass
Vinegar or weak HCl	Graph paper
Soil sieves	Clipboards
Soil identification cards	Paper towels
Centrifuge tubes or settling tubes	Camera and film
Test tubes	Cell phone
Hula-hoops or sampling grids	

Safety Notes

There may be safety concerns when working in urban areas. Make sure that students are adequately prepared and do not go to the site alone. Make sure that neighbors are informed of that students will be working in the area. Notify local authorities if appropriate. Students should wear goggles and gloves when handling chemical test kits. Read and follow all safety precautions included with the kits. Plan access to a chemical shower and eyewash.

Schedule of Activities

SESSION 1. Introduction of project and initial site visit. The purpose of this week is to acquaint students with the site and the project. This is a good time to have the community partner present to describe the project and to discuss areas of concern.
While at the site students should:

- Make general observations of the site.
- Take measurements and map the site.
- Generate questions to be addressed by their study.

SESSION 2. **Class Discussion.** Students discuss their site visit and compare maps and notes. Consensus on the major questions should be reached. A plan for evaluating the site should be generated. This time may also be used to introduce methods for soil testing.

SESSION 3. Site Visit. This time is used to divide the site, run transect lines, or select sampling sites. Detailed maps should be made of the area at this time. Maps should include morphology as well as major vegetation. Students should look for evidence of animals and human impacts.

SESSION 4. Class Discussion. Students should come to class prepared to discuss environmental elements necessary to a healthy ecosystem including chemicals necessary for plant growth (*e.g.*, pH, N, P, K), physical characteristics, and soil composition. Environmental toxins are also addressed here. Students practice with test kits. Depending upon the intended use of the site, students may learn about native species or organic gardening. A list of questions for the community partner is drafted and students are selected to ask them.

SESSION 5. **Soil Sampling**. Students visit the site and collect samples. Chemical testing may take place on-site or back in the laboratory as time permits. Students finalize maps and identify species.

SESSION 6. Laboratory Work. Students work in the laboratory to finish any testing necessary. Data are pooled. Student papers and group posters are assigned or reviewed. If time permits, site cleanup should be done.

SESSION 7. Presentation of Data. Students present their posters to the class and the community partners. Individual papers are collected and the instructor writes a final summary report to be delivered to the community partners.
Clean the site if this has not been accomplished already.

Student Outline

Arboretum Project
After completing this activity, you will be able to:
1. Design and conduct a series of experiments to address a local environmental issue.
2. Test soil and interpret your results.
3. Effectively communicate your findings to the community partner.

Introduction

The City of Bowling Green has recently acquired an 8-acre tract of land to develop as an arboretum. This land was the site of the water wells that provided water to the residents of the area in the middle of the last century. The area has long been known as the Waterworks. Since the wells were capped and lapsed into disuse, the site has primarily served as a site for dumping construction waste and soils.

There has been no analysis of the soils, plants, or animals at the site. You will be providing the first survey of the area to the Park Naturalist. He is hoping to get enough information to begin the process of evaluating the site and determining critical needs. Of particular interest are the large piles of concrete and asphalt scrap that line the south border of the property.
You must plan carefully and ask appropriate questions to provide useful information to the City for this project.

Planning Week

You have one week to use as a planning session. As a group, you will review your ideas and come up with one common question to explore. You may use any technique that you have learned to collect data. Determine the question and design the experiment. You are free to choose your project and the techniques you will use as long as you use common sense, follow a few simple rules, and have the project approved by your instructor. Be prepared to present your research question, hypothesis, and experimental design to the class.

Important Notes:

- Your instructor MUST approve your project by signing the group contract prior to starting the experiment. You will not get credit for projects that have not been pre-approved.
- Your project must address an issue directly related to environmental science.
- Your instructor will assist you in obtaining standard laboratory materials you might need. You will be responsible for obtaining any other materials you might need.
- You may not do any experiment involving humans or other vertebrate animals. (Experiments of this nature must meet institutional and governmental guidelines for seeking formal approval, which cannot be obtained for this project.) You will not receive credit for experiments using humans or vertebrate animals.
- You will need to collect your own samples.
- If you sign the contract saying you will bring a sample to class, it is your obligation to do so. You may lose points if you fail to bring it.
- Do not collect samples from private property (this includes commercial properties and businesses) without written permission from the owners.
- Do not disrupt the ecosystem you are observing by digging holes, leaving trash, or taking plant or animal material from the site.
- Do take pictures of the site and draw detailed maps of the locations you are sampling.

During the planning session, you will fill out your group contract. You will exchange email addresses (phone numbers are optional). You will agree on the time and location of your out-of-class meetings. You will decide upon and write down your research question, your hypothesis, and your experimental design in your own journal. You will decide who will collect what samples under what conditions. You will decide what sources of information (maps, newspaper articles, zoning laws, research on organisms) you will need to find to understand your project, support your hypothesis, or help interpret your data. Finally, your instructor will sign your group contract approving your project. If you are not clear on any of these steps, it is your personal obligation to clarify the details BEFORE you leave the laboratory.

Working Week

Come to the laboratory prepared to conduct your experiment. To do so, you must have already met with your group, visited your research site or sites, and collected your samples. You will have to provide your own containers for sample collection. You need to make sure that appropriate samples are collected and brought to class for the working week. Remember, if you fail to bring your samples to class, your group will be unable to complete the project and you may personally lose points. You also need to bring the supplemental information you agreed to locate.

During the working week you will do all of the tests on your samples. You will pool any data about the sites that you collected outside of class. You will personally have a complete set of raw data in your journal. Share copies or sources of information. You will review the time and location of your next out-of-class meeting. You may use any remaining time to begin to analyze your data, draw your conclusions, and summarize your results.

You must be present in the laboratory during the working week to get full credit for this project.

Poster Session

You will report this project to the class in a poster session that will take place in class two weeks after the working week. Follow the "Making a Poster" guidelines in the Tools and Techniques section of your laboratory manual. The poster is group work and will be evaluated using the rubric in the assessment section of the laboratory manual. Even though this is a group project, everyone must keep a complete journal entry for the entire project. You are responsible for your own summary. You must be able to speak to the class about all aspects of your project. You will use the group self-evaluation forms to provide anonymous input to your instructor about your group members. They will provide information about you. Be fair and constructive.

Analysis Paper and Poster

Summary of your group plot

The summary needs to include detailed information regarding your designated plot. It should contain a map of your site including:

- Dimensions
- Where your site is in larger plot
- Any and all sites of testing
- Any other significant information within your plot

Clear statement of your results

This should be a clear summary of the information you gather about your plot. Be sure you discuss what tests you ran and why you chose these particular tests. Be sure you have a clear analysis of your data; do not simply restate your results. It is your responsibility to interpret these results in terms of the site. Explain how your results will impact turning this site into an arboretum, with native plants.

Recommendations for your site

Include any additional work and/or experimental data that will need to be collected as a result of your work. This may include remediation of chemical pollutants, any soil amendments (addition of fertilizers, *etc*.), and planting suggestions of native plants.

The Paper: *DUE:*

Each person is required to submit **an individual Analysis paper** about the Arboretum Project. The paper MUST BE TYPED and no longer than two pages of typed text and will be worth 15 points. You may add additional pages of a map, results, *etc.,* but please try to keep additional pages to a minimum. It is important to think and determine the best way to display the results so someone could easily understand them. If you have additional pages, be sure you label them (Figure 1, Table 1) and discuss them in your paper.

The Poster: *DUE:*

The poster will follow the same format as the rubric in your lab manual, and shall contain an Introduction, Materials and Methods, Results, and Conclusion sections. Additional information will be given in class about the poster. The poster is worth 40 points, and the presentation 5; total is 45 points.

Biological sampling

The health of an ecosystem can be tested in a wide variety of ways. One of the first things that can be done to measure environmental quality is to survey biodiversity. In particular, scientists look for the presence of species that are sensitive to pollution. The more of these delicate species available, the less pollution is presumed to be in the ecosystem.

A. Aquatic Sampling

You need to use a microscope to sample aquatic organisms. Refer to the section on using the microscope to make sure you know how to use this tool. Your instructor will demonstrate how to use the plankton net to get samples from the pond. Take a drop of this sample and observe it under the microscope. Each student should observe two different fields in one drop of plankton. Each student should record the type of species and the number of each species found in each of field. Use the diagrams and keys in the lab, or provide a detailed description if you cannot identify the species. Pool these data from the entire class and record it in the pond database. (Your instructor will show you how to do this.)

B. Hula-Hoop Sampling

1. Place a hula-hoop randomly in the area you have been assigned.
2. One member of your group will serve as the botanist. This person will identify each species, making additions to the herbarium if necessary. It is the botanist's job to make sure that your group is using the same language to describe the same plants as the rest of the class.
3. A second member of the group will serve as the recorder. This person will record the original data, present it to the class, and make copies available for the other members of the group. (The other members should make sure that they can read and understand the recorder's work and verify that it is accurate.)
4. The final member of the group will be the field scientist. This member will count the number of plants of each species inside the hula-hoop. This person will also observe and record any human activities in the sample site and any animals that might be present.
5. Once you have collected your data, make a chart, graph, or table that illustrates the species diversity in your sample. Draw some conclusions about the health of the ecosystem that you are sampling.

C. Sampling Using a Grid

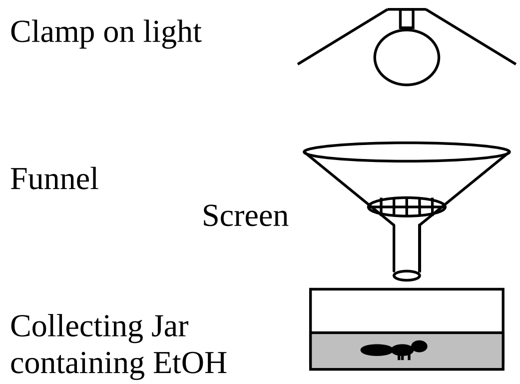
The grids in the lab are one meter square. Each cross string is at 10 centimeters. Place the grid on the vegetation in the area you have randomly selected. Count all of the different species in each 10 cm x 10 cm section. This method is most useful for small areas and small plants. Areas with large trees and shrubs are better sampled using the transect method.

D. Sampling Using a Linear Transect

Randomly determine the starting point for your transect. Make sure that it is well within the boundaries of the area you wish to sample. Secure one end of your tape or string to this point with a removable stake. Walk in a straight line in the predetermined compass direction until you reach your limit of 25, 50, or 100 meters. You may have to make minor adjustments around large tree trunks. Secure the other end of your line at this point.

E. Soil Sampling

Soil samples may be collected using the tools provided in the laboratory. Some of these are for profiling soil. Others are simple shovels. Soils should be stored in bags or bottles. Make sure there is sufficient air for the soil if you are going to look for arthropods or other living organisms. Arthropods are one of the key organisms found in soils. Since they live in soils, they are difficult for humans to observe. A Berlese funnel apparatus is used to collect organisms.



Berelese Funnel Apparatus

Soil samples are added to the funnel. The light is turned on and the samples are left for 24 hours. At this time, the organisms in the collecting jar are observed, identified, and recorded. Your instructor will help you obtain soil samples for comparison.

Chemical and Physical Tests

Another way to measure environmental quality is to do tests for chemical and physical qualities. There are a series of tests and tools that can be used to measure water and soil quality. Each of these tests involves the use of chemicals that may be harmful to you and the environment. It is critical that you observe all rules and instructions carefully. Be sure you pay attention to how to dispose of the materials properly.

> *Safety glasses are provided in the laboratory and must be used at all times when doing chemical tests. Every member of the group is required to wear them. If proper attention is not paid to safety, you may be asked to leave the laboratory, which will be considered an unexcused absence.*

Chemical Tests

A. Dissolved Oxygen.

Oxygen is essential for healthy aquatic ecosystems. Fish and other organisms extract oxygen from the water. On your bench is a kit for testing dissolved oxygen. Inside are instructions. Your instructor will demonstrate this procedure. Follow instructions carefully.

B. pH Chemical and meter tests

pH is another critical component of an ecosystem. Most organisms are only able to tolerate a limited range of pH values. There is a chemical test kit on your bench. Your instructor will demonstrate the use of this. Record the instructions in your journal. There is a pH meter available as well. Record instructions as demonstrated. pH can be determined for soil as well as for water. A soil test kit is available on your laboratory bench.

C. Other chemical test kits.

There are a variety of other chemical test kits available in the laboratory. Be sure to use the soil test kits for soil and the water test kits for water. Each comes with specific instructions. Follow them carefully. Record your results.

Common chemicals tested for in the environment

Chemical Factors	Significance	Precautions
Dissolved oxygen in water	Oxygen is necessary to life. Healthy ecosystems have a dissolved oxygen concentration of approximately 7-8 PPM. Lower levels of dissolved oxygen can be an indication of eutrophication.	Must wear goggles and gloves.
pH water and soil	This is a measure of the acidity or alkalinity of the soil and water. Most living organisms survive best in a pH environment close to neutral, or pH = 7. Lower numbers indicate an acidic environment and can be an indication of acid rain or acid deposition in the environment. Higher pH values can be an indication of other chemicals in the environment. Both soil and water pH can be measured using meters, chemical tests, or paper strips.	
Nitrogen (N)	Nitrogen is an essential element in plant growth. Review the Nitrogen cycle. Too little nitrogen in the environment can result in reduced plant growth. Too much nitrogen can result in abundant growth particularly of algae in aquatic ecosystems; this can lead to eutrophication. Too much nitrogen in the soil can leach into the water supply resulting in eutrophication.	Must wear goggles and gloves.
Phosphorous (P)	Phosphorus is an essential element in plant growth. Review the Phosphorous cycle. Too little P in the environment can result in reduced plant growth. Too much P can result in abundant growth particularly of algae in aquatic ecosystems; this can lead to eutrophication. Too much P in the soil can leach into the water supply resulting in eutrophication.	Must wear goggles and gloves.
Potassium (K)	Potassium is an essential element in plant growth. Too little K in the environment can result in reduced plant growth. Too much K can result in abundant growth particularly of algae in aquatic ecosystems; this can lead to eutrophication. Too much K in the soil can leach into the water supply resulting in eutrophication.	Must wear goggles and gloves.
Chloride (Cl)	Chloride is an element that is essential in small amounts but can cause problems in larger amounts. Presence of Cl can indicate the presence of other environmental toxins such as PCBs and other harmful elements.	Must wear goggles and gloves.
Lead, Mercury	These are elements that are commonly associated with industrial processes and mining. They have common negative health effects on humans.	Must wear goggles and gloves.

Physical Tests

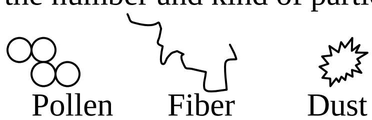
A. Using the pH Meter.
1. After the tester is inserted into the sample, the pH meter will stabilize in 2-3 minutes.
2. Read the meter from the top scale.
3. There is a separate apparatus for measuring water pH. This must be calibrated before use. Follow the instructions provided by your instructor.

B. Soil Moisture Meter.
1. Press the button on the side and hold it.
2. The meter will stabilize in 2-3 minutes.
3. Read the moisture on the bottom scale.
4. This meter gives you a reading of percent saturation. The higher the number, the greater the amount of water held in the soil.

C. Soil Characteristics.
Use the magnifying glass or dissection scope to compare your soil sample to the card. This will give you an overall description of the soil type you are studying.

D. Temperature.
There are several types of soil water and air thermometers. Place them in the sample and allow them several minutes to equilibrate before reading.

E. Air Particulate Sampling.
Take a 1" square piece of double stick tape. Apply one side of the tape to a 3 x 5 card. Leave the remaining side covered until you have the card in place. Choose the area you are sampling. Secure the card so that it will not be moved for three days. Peel back the tape. After three days, carefully place the card in a zip lock back and return it to the laboratory. View your sample through the plastic to determine the number and kind of particulates present in the sample.



F. Noise.
Sound can disrupt living organisms in a variety of ways. Noise is measured in decibels and can be measured using a special meter. Follow the instructions provided with the decibel meter to sample noise.

G. Light.
You may be able to use the light meter on your manual adjust camera to get a general measure of light. You may record your data as shutter speed or aperture to compare relative amounts of light.

Common physical factors tested for in the environment

Physical Factors	Significance	Precautions
Soil particle size	Size of particles can affect the quality of the soil. Large particles, lots of rocks, and/or little organic material can all be indications of a low quality soil.	
Soil chart	Information about soil characteristics learned from using these charts can provide clues about soil quality.	
Light	Light is essential for plant growth. The number and kind of autotrophs can determine the biomass that can be sustained by the environment. Likewise, light pollution at night can disrupt the biorythyms of nocturnal organisms.	
Moisture	Water is essential for life. Too much water or too little water can be a problem for organisms.	
Noise	Noise pollution can disrupt organisms by interfering with communication and hearing.	
Temperature	Organisms have optimal temperature ranges. Seasonal changes in temperature can affect life cycles. Increases in water temperature due to thermal pollution can reduce the dissolved oxygen available.	
Particles in the air and water	Air quality is a key element of ecosystem health. Organisms such as birds and insects use different methods to extract oxygen from their environment. Particulates in the air can clog these systems. Particulates in water are often caused by erosion. Some organisms use cloudy water to evade predators. In other cases, the sediments can create problems for organisms requiring clear water.	