Virtual Lab Teacher Guide

How Big is Your Footprint?

To understand science process, students need practice with science investigation. Virtual labs are designed to give students the opportunity to practice designing and conducting virtual investigations in preparation for designing and conducting their own hands-on investigations. Virtual labs take between 2 and 4 class sessions to complete.

The advantage of a virtual investigation is that conditions are more controlled than during hands-on, allowing students to focus their attention on the logic of the design and the results of the investigation. Virtual investigations can be repeated quickly, and can provide investigative experiences that are not available through hands-on due to constraints of time, resources, or safety.

Virtual Labs are not intended as totally independent student activities. A critical point in the lab sequence is the student-developed plan to conduct the investigation. Investigative plans are approved by the teacher prior to students entering the Investigate section on their own. Because students will test one variable at a time, it can be preferable to have each student group collect data on just one variable, then collect all the data from the class and analyze all the variables as a large group. This is typical of science research.

Discovery Science Connection virtual labs support inquiry learning by providing students practice with the following National Science Education Scientific Inquiry Standards:

- Developing testable questions
- Evaluating and designing a fair test
- Gathering and interpreting data
- Developing explanations from data
- Evaluating evidence
- Communicating science
- Using mathematics in inquiry

It is important to note that the elementary virtual labs do not provide a “control,” that is, a second investigation running alongside the first in which none of the variables are changed. The concept of using a control is complex and is introduced once students understand how to set up a fair test and conduct a simple investigation.

Virtual labs contain three parts:

Introduction: This part sets the stage for the investigation by presenting a real world problem around which the investigation is based. It also describes the two levels of difficulty students will find in the Investigate section.

Investigate: This tab allows students to select the lab level, sign in and begin conducting the investigation, one trial at a time. The first level offers a simple choice of choosing one variable to control. The second level complicates the investigation with multiple options or multiple test subjects to observe.

Results: This tab provides students with a record of the results of each trial in chart form. Students also are provided with a paper copy on which to record the data.

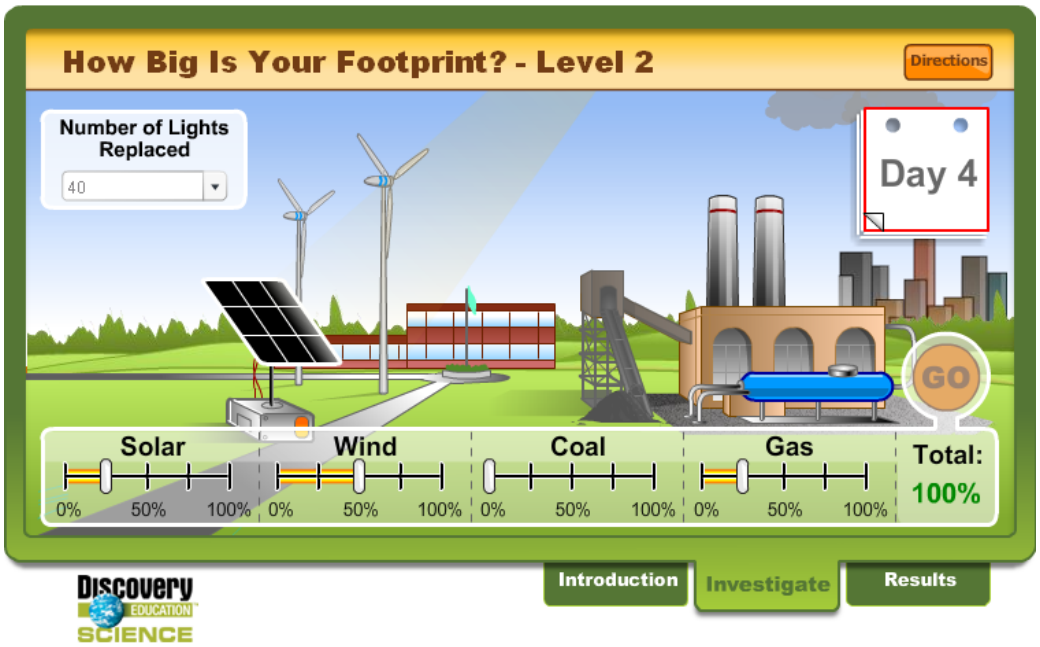
How Big is Your Footprint?

Overview

How Big Is Your Footprint puts students in charge of a business. The business wants to "go green" and reduce its carbon footprint. That's the amount of carbon its energy use puts into the atmosphere. But it also wants to keep costs down so it doesn't go out of business. Students must choose among different sources of energy for the production of electricity for an office building. In level 1, students explore combinations of four sources produce the smallest carbon footprint while trying to keep the cost of the electricity to a minimum. In level 2 students can additionally choose to replace up to 100 standard light bulbs with more efficient Compact Fluorescent Lights (CFL's). They must factor the CFL cost into their expenses for one month and find out how much energy is saved by using them.

The typical sequence for instruction is to:

- Use the Introduction tab to set up the problem with the class.
- Demonstrate how to get into the lab through the Investigate tab.
- Show students how to manipulate the variable selector controls, run a trial, and review data in the Results tab.
- Stop the lab and model for students how you would use the student planning sheet to design an investigation on paper.
- Finally, assign students to groups to develop their plans to investigate just one variable.
- As each plan is approved by you, students can be assigned to work on a computer.
- Once students have collected their data, analyzed it, and drawn a conclusion, they prepare a report and share it with their fellow scientists.
- Bring the class together to discuss what each group found out about how their variable affected the size of the carbon footprint and the cost of the electricity, and have the class conclude what the best combination of energy sources must be, based on the data.



How Big is Your Footprint?

Introduction Tab

This section introduces students to the problem question, "What is the best combination of energy sources that will minimize the carbon footprint while keeping the cost down?" and describes the two levels of difficulty for this lab. The scenario places them in charge of the energy costs for a business that wants to "go green" but must keep costs down.

Investigate Tab

This section offers students a choice between the two lab levels. Only one lab should be conducted by students at a time. Students also log in so that their data table shows the name(s) of the investigators.

- Level 1, students select how much of each energy source they want to use to generate the electricity for an office building. The total of their choices must add to 100%. They will find that the more coal and gas they use, the larger the carbon footprint and that by choosing solar or wind they can reduce the size of the carbon footprint. There is a tradeoff however – coal and gas are fairly inexpensive. Solar and wind have low carbon footprints but are more expensive. The challenge for the students is to discover what the various combinations cost and what carbon footprint they produce. Students then make recommendations about the cost they are willing to bear to reduce the size of the carbon footprint. It is recommended that students work with Level 1 first since the variables and results are simpler than Level 2.

- In Level 2, students are given an additional option (variable) of changing the standard light bulbs in the building with Compact Fluorescent Lights (CFLs). They will discover that by replacing standard lights with CFLs, they can reduce the size of the carbon footprint and the cost of the electricity. They can change up to 100 lights and the more they change, the greater the cost and footprint reduction.
  Note: Students will have to convert the weekly cost of electricity on the output screen to electricity cost per month on their record sheet. Their monthly budget for power and light bulbs is $2,000. They cannot exceed this and stay in business.

Results Tab

In Results, data is provided as it is collected by the computer during the Investigate phase. Depending on the level selected, the computer provides the appropriate data chart with the results of each trial the students conducted. Students may move back and forth between the investigation and the results. However, this data must be printed out or recorded before exiting the lab or it will be lost. Students are provided with a record sheet to record the data for themselves for further study.

How Big is Your Footprint?

Background Content for the Teacher
This lab presents a highly simplified circumstance. However, it represents a very real situation. As the U.S. power grid grows, more and more power companies are offering customers choices for where their electricity originates. Fossil fuels obviously put the most carbon into the atmosphere. They have the largest "carbon footprints" but, for now, they are still the cheapest sources. Both solar and wind power plants have small (but not zero) carbon footprints but are still relatively expensive. The reason for this lies in the use of energy needed to make, transport, construct and maintain the materials used in generating electricity by wind (turbine) and solar (panels or cells).

Carbon levels in the atmosphere are considered by most scientists to be the primary contributor to global warming. The reasons why these levels have risen so dramatically in the last hundred years are complex and not completely understood. What is clear, however, is that human activity has contributed to the rise in many ways and that energy consumption is a major factor.

Carbon Footprint: This is the total amount of carbon (primarily carbon dioxide) contributed to the atmosphere by a person's or a business's activity. It's important to note that a carbon footprint is not solely comprised of electrical power usage. Transportation choices, food choices and many other things in our lives affect how much carbon we indirectly place into the atmosphere. However the complexity of all those factors is typically beyond the ability of most elementary students to monitor or understand. Thus, this lab focuses on one factor that is an obvious contributor to atmospheric carbon pollution.

The rules built into this lab reflect these facts:

- Coal alone produces the largest carbon footprint which is set at 100. All other sizes are relative to this. Wind alone produces the smallest footprint with a size of 1.
- CFLs consume about a fourth the electricity as standard light bulbs and they cost about twice as much.
- About half of an office building's electricity goes for lighting.

This lab provides a good discussion point to review renewable and non-renewable forms of energy. You will find many other resources in Discovery Education Science for Elementary that support this content.

Suggestions for Timing and Organization
On average, each level of the lab requires between two and four class sessions to complete.

First Time Users. If this is the first virtual lab your students conduct, you may need to take one whole session to go through the lab once with the students, demonstrating how it functions and modeling the planning, data collection and evaluation you want them to do. Because you will only be choosing one variable to test, students will still be able to run the lab on their own using the variable they choose.

Experienced Users: If students have already designed and conducted a lab before, it will usually only take part of one class session to introduce the lab and show how it functions. Students will then need time to develop their investigative design and present it for your approval. Once it is approved, students will need a class period to run the trials, collect the data and write up their explanations.

Grouping: It is best for students to work on the labs in small groups of 2 – 4. Mixed ability grouping works very well in this science exercise.

Presentation of student's findings to their peers takes time. One way to reduce presentation time is to employ a method used by scientists called a poster presentation. Students formally write up their data and results and post it around the classroom for others to review and comment on. All students carry comment sheets as they take a "wisdom walk" in which they read their peers' results. Comment sheets can be placed next to each report or you can have students take notes as they go.

Explaining a "fair test"
If this is the first lab they've done, this is a good time to discuss a fair test (the introduction to variable control). In experiments, scientists must change only one variable at a time for it to be a fair test. Demonstrate this by running two trials. Use Level 1 to keep the variables and results simple. You can also use this demonstration to show students how the variable selectors in the virtual lab work. Rather than jump back and forth to the Results tab, it may be better to record the outcomes on a board so they can see the results and the lab at the same time.

Level 1
Trial 1: Choose – 50% coal and 50% gas
Trial 2: choose – 50% solar and 50% wind

Explain to students that you got different results, but don't know which variable caused the difference because all the variables were changed. If we want to know which variable affects the carbon footprint the most, we have to only change one variable at a time. This is called conducting a fair test.

Modeling the Plan to Investigate (for first time users)
Scientists always use background knowledge to develop their ideas. Model this thinking by asking students what they know about the amount of pollution that is produced by power plants that burn coal as their fuel. Then ask them what they know about the amount of pollution produced by wind turbines or solar panels. Example: "I think coal pollutes the air more than wind turbines."

Use chart paper or chalk board to model for students how you would plan the investigation. Develop a testable question that involves one variable. Example: “How does choosing all coal for making the electricity compare to choosing all gas or all solar?” Ask out loud, “What will I be changing in each trial?” “What will I have to keep the same in each trial?” Record this. Then invite students to describe what you should put down on the chart. What will each trial involve? Complete the plan so they can see how it’s done.

The final product can be a brief report that recommends what combination to use based on data from the investigation.

Guiding Students as They Develop and Conduct Their Investigations
Organize students into their lab groups (2 – 4 per group). They will now develop their own questions and plan their investigations. Keep the virtual lab visible on the projection screen as well as your plan so they will be able to relate what they are planning to what they can see. Go around and guide students through the planning process. They should be able to show you how many trials they will conduct and which variables will change and which stay the same for each trial. Once you have approved their plans, you can assign groups to the computers to begin the investigation.

If students are in a computer lab, you can go around and monitor their activity. Try to use guiding questions, rather than correcting them or suggesting what to do next. Be sure they are following their plan and recording their results. It is not uncommon for students (or scientists) to wish to change their plan, once they get into the actual lab. If so, they must give you good reasoning and explain the logic of changing their plan. The plan must be revised and approved before they can continue or before they start the lab over.

