1 | Abstract

Communities in south east Idaho are very involved in exploring and developing alternative energy sources, and during the past few years there have been over 100 wind turbines installed in the surrounding area. The implementation of this new technology is the basis for our project.

In the back corner of the school's playground is a small hill that seems to be the windiest place on earth, and it has been suggested that with the help of the Idaho National Laboratory the school install a small wind turbine. Gary Seifert, director of the Wind Project at the INL offered to help us get a wind turbine, but we would need to have a year of wind speed data. The students will use the probe-ware to collect wind speed data daily from three locations on the school grounds. Along with the data collection, the students will explore how wind turbines work (National Energy Education Development, NEED, project materials), how the design of the turbines effect energy production and the expected electricity output. While studying the science and engineering of wind energy the students will monitor the local weather, focusing on wind patterns to determine if our hill meets the criteria for a productive windmill. The students will calculate the average weekly wind speed on our playground and compare our data to that of the local weather service. The culminating activity will be to present our data and findings at a school board meeting with guests from the INL in attendance, and hope we will be able to install a windmill in our backyard.

2 | Program Description

Energy for Idaho

I have often joked that my philosophy about education is "the bigger the mess, the more we've learned". Recently I was reading some research about the integration of literacy with science and technology and found a more refined way to express this opinion. There have been several studies, as reviewed in a 2004 report by the National Center on the Assessing the General Curriculum, that show that when students are engaged in field work or authentic investigations they are better prepared to understand the concepts to be learned. Prior knowledge through experience gives the students an anchor point by which to organize and internalize new knowledge. The pedagogical philosophy behind this project is to build background understanding in the areas of weather, energy and the study of data to lay the foundation for our in-class studies.

I teach a multi-age class in which I integrate fifth and sixth grade students and curriculum. Over the years I find that the sciences which are more theoretical than physical are the hardest to teach. To improve my instruction in these areas I have participated in numerous in-service classes which have not only increased my understanding of the content, but provided me with new pedagogical strategies and activities. By participating in the National Energy Educational Development program (NEED) I received training and materials to teach the science of energy and alternative energies.

The next class in which I participated introduced me to digital data collection. In the past, data collection at the elementary level has been crude, unreliable and often so distorted that the results confused the students instead of supporting their learning. This year as the

students have been studying Newton's laws they were able to track the motion of an object, calculate its speed and velocity using a motion detector and LoggerPro© on a computer.

The excitement that I witnessed from my students over data has prompted me to find other ways to get my students involved in authentic science based on data. The unit we use to introduce and teach alternative energy sources is the Interact® simulation Survival. It guides the students through a process of analyzing geographical locations to determine the best location for societal development. This unit has often not connected with the students. My students live in the middle of the city and rarely have the opportunity to travel. They figure that "society" has been settled and developed, so why study the process.

During the Survival simulation one activity requires the students to evaluate the infrastructure needed by a population to assure being able to provide sufficient energy. This discussion triggered comments from my students about how windy our playground seemed to be, especially the northwest corner which has a small rise, commonly known as the "hill". The students proposed that we put a windmill in the school's backyard and save the district "a ton of money".

In response to their suggestions I contacted Mr. Seifert at the INL and discussed the requirements for installing a small wind powered turbine. I also contacted Mr. Cairns, the principal at a local high school, for advice because his school has a windmill in use already. The first step we needed to take was to start to collect wind data. We used two different manual wind meters and started a monitoring program. The data was inconclusive because the

readings were subject to student interpretation and our quest for a windmill was put on hold. The students need for more precise data is the basis for the proposed project.

The windmill project will use the students' questions as the basis for a real scientific investigation. Students are motivated by investigations, and it has been shown in many studies that students learn more when they are actively engaged in learning. But when the investigations are contrived and the students do not see clear connections to their lives the learning is not as deep as it could be. Using the current curriculum the students are aware that south east Idaho is a prime location for many alternative energies. Our city of Idaho Falls relies heavily on hydro-electric power, there are several areas which could support geo-thermal and solar energy, and one of the biggest employers of the area is the Idaho National Laboratory which is doing research on nuclear energy and biomass energy. Because this project comes from the students and will directly impact their school and neighborhood it will have a long lasting impact on their lives. Not only will it teach them to use science to answer their questions, but it will also help them realize the possibility of energy related career choices.

The energy unit will begin with a study of the basics, which will include the science of energy, and how energy can be changed from one form to another and how we get the electricity we need. When the students have a strong foundation I will introduce the wind power program. I will start with the outdoor lab having the students investigate weather patterns, the winds, become familiar with various weather measuring instruments. By starting with the outdoor lab and the long-term data collection, I will create a reason for continuing with our studies of windmill design. Through these activities the students will develop their

observation and record keeping skills and will practice using scientific tools to collect data for analysis.

The indoor lab will focus on teaching the students how to set up investigations and choosing their variables. The students are familiar with the investigation procedures recommended by Michael Klentschy (Using Science Notebooks in the Elementary Classroom) and will work through the prescribed steps; ask a question, make a prediction, create a plan and write a procedure, make observations/use evidence to support claims, summarize what you have learned, ask a new question.

One of the most important aspects of this project will be student centered learning. To this end I have set the goal to find and develop projects from the questions they ask. This willingness to follow the students' interests and concerns has led to some of the best discussions and investigations. This energy unit will not be complete until we take our proposal to the school board and lobby for the installation of the windmill. The students will learn that their hard work can bring about change and can benefit their community. They may not be able to determine a location to start a society, but they can affect their community, its development and its sustainability,

The Idaho science standards for the fifth and sixth grades which I plan to address in this project are:

Nature of Science: use observations and data as evidence on which to base scientific explanations and predictions; conduct scientific investigations using a control and a variable; select and use

appropriate tools and techniques to gather and display data; use evidence to analyze descriptions; explanations, predictions, and models

Personal and Social Perspectives; Technology: describe how science and technology interrelated and how they play part of our society; identify the differences between renewable and nonrenewable resources

Earth and Space Systems: describe the interactions among the solid earth, oceans and atmosphere and how they affect climate, weather and weather patterns

Physical Science: classify energy as potential and/or kinetic; explain that energy can be transformed but cannot be created nor destroyed

Klentschy, Michael P., Science Notebooks Essentials, Science and Children, Nov/Dec 2005, pg. 24 – 27.

National Energy Education Development Project, http://www.need.org/ web 11/17/11

Strangman, Nicole and Tracy Hall, Background Knowledge, National Center On Accessible Instructional Materials, http://aim.cast.org/learn/historyarchive/backgroundpapers/background_knowledge web, 11/02/11

Vernier, http://www.vernier.com/, web 11/9/11

7 | Lab Activity

During this unit there will be many lessons that lead to and support the two planned investigations, but the main goal of the labs is to get the students involved with learning science and to undertake a project that will benefit the school. Traditionally "what happens in the classroom, stays in the classroom". I want the students to understand that all learning is guiding them to a better understanding of the world around them. This understanding will not be limited to just my students, it will extend to the parents and families.

I mentioned in the project description that south east Idaho has many energy resources, but their implementation is not without controversy. The wind farms' criticisms include the environmental impact on the land and wildlife and the aesthetic impairment of having the windmills on the hill. Nuclear energy has the potential of radiation contamination of the environment, especially the aquifer. Even with hydro-electricity there are many discussions about damming the river and the effects damming has on water rights. As with many controversial issues the news is full of opinions, and these opinions are not always supported by science. As I work with the students and we complete the labs and project, I hope to instill the concept that facts and science needs to shape their decisions and opinions. And as the students learn this lesson, they will be able to take the lesson the community.

8 | Lab Activity

Wind Monitoring Lab (outdoor lab)

Objectives

Students will discuss their prior knowledge about wind.

Students will use environmental clues to assess wind speed.

Students will measure wind speed using different tools. (anemometer, wind gauge, digital anemometer (Vernier).

Students will collect data over time by measuring wind speeds daily during the school year and create monthly charts using the information collected.

Materials

paper cup anemometer
- snow cone paper cups
- long straws
- tape
- hole punch
- scissors
- straight pins
- markers

wind measuring
- anemometers
- wind gauge
- stop watch
- science notebooks
- pencils

Procedures

1. Take students outside with their science notebooks to observe and note the behavior and effects of the wind.
2. Have students construct paper cup anemometers and have students use them to record and chart wind speeds.
3. Take students outside with their science notebooks, real anemometers, and wind gauge to make wind observations. Begin by having students record the direction the wind is blowing. Do one or two observations as a class and use wind gauges and anemometers to take wind measurements to compare to the predictions. Then let students explore different areas around the school grounds and record some wind speed observations and predictions independently.
4. After data is collected students will calculate mean, median and mode for each set of data, identifying and analyzing the data patterns.

LONG TERM DATA COLLECTION

5. Continue collecting wind speed data daily with digital probe from the top of the playground hill. With accumulated data the students will calculate mean median and mode for each week and each month. These findings will be compiled in a report for the school board and INL representatives.

Assessment

In teams of 4 the students will use their data to prepare a presentation. The presentation should include graphics (tables, charts, graphs) created from their raw data. The students will explain to the class what effect they believe the weather has on electricity generated from wind.

Windmill Design Lab (indoor lab)

Objectives:

Students will use windmill models to investigate how mechanical energy can be used to create electricity.

Students will design, build, test, and evaluate wind turbine blades to achieve the highest possible electrical output and work production.

Materials:

emergency flash light and radio which gets power when you crank or squeeze handle
hand cranked generator
windmill model kits (NEED Project)
poster board for blades
tape measure
science notebook
small LED lights on wires (Christmas lights separated)
basic turbines
fans
current probe (Vernier)

Procedures:

1. Discuss how mechanical energy can be changed into electricity by the use of a generator. Have the students connect the hand crank generators to the light bulbs and notice that the more they crank, the brighter the light.
2. Following directions from the kit instructions, have students build windmills. Work with students to make sure all windmills are working using a simple generic design. Guide the students through the first investigation testing wind/fan speed. Practice reading the current probe and recording the data.
3. Discuss different types of turbines used by wind power companies. Discuss blade variables that would affect energy production; quantity, size, pitch, material, mass of blades. In teams of 4 students will plan a blade investigation selecting one variable. Following the procedures set during the teacher guided investigation, the students will proceed with their group activities.
4. The students will summarize their data and report their findings using graphs and charts. Each group will share their findings with the class.

Assessment:

The students will demonstrate their understanding by redesigning their investigation, changing one variable, to make the most productive windmill. They will share their designs and explain to the class the reasoning behind their decisions.