# 1.6 METEOROLOGY EDUCATION THROUGH NATURE CENTERS

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## 1. INTRODUCTION

For over a decade there has been a repeated national call for greater instructional emphasis on integrating mathematics and science posed in "real-life" situations. National educational associations such as the National Council of Teachers of Mathematics (NCTM) and the National Science Teachers Association (NSTA) support the notion that access to effective mathematics and science education be made accessible to all children.

Traditionally, mathematics and science are subjects taught separately in schools and relegated to specific points within the daily schedule (Barba, R., 1995). Numerous studies show that the teaching typically relies on expository teaching methods that all too often have the children experience the learning from a distance. As casual bystanders, they become disenchanted with subjects and knowledge that should cause them to brim with excitement and anticipation.

Nature Centers are an excellent means of educating the public about natural science. They reach a wide audience with an age range varying from preschoolers through adults. Many of these centers do a wonderful job of educating in such areas as biology, geology, and environmental science; however, it is seldom that one sees a nature center exhibit or program that emphasizes physical science or mathematics. Here we seek to rectify this missing element by developing displays and programs that use meteorology to exemplify physical science and mathematics in the natural world. When people learn about physical science and mathematics in an informal setting, they see the relevance and applicability of what they learn.

In a collaborative project with the Stokes Nature Center in Logan Canyon, Utah, integrative, interactive displays and programs helping children and adults learn important mathematical and scientific principles centered on the study of weather and climate are developed and piloted. The displays and programs use the natural themes observable in the surrounding environment. The centerpiece of the education programs is a weather station sited near the nature center. This station presents a display within the Nature Center and includes interpretative plots of the data. Data are integrated with other data from nearby stations. Displays are included to explain the weather and climate of the region. In addition, children's programs are being developed for visiting school groups and for teachers who wish to develop classroom meteorology units. Specifically, we integrate physical science and mathematics State Core Curriculum objectives in the presentation and study of meteorology through hands-on displays and experiments. The programs include outside environmental observation and using simple instruments to measure meteorological variables. Students are aided in integrating and interpreting their observations and data. Students use the integrated picture to predict the next day's weather. Teachers then follow-up in the classroom to assess the children's predictions. In this way, school children learn about meteorology in the natural environment plus use mathematical skills to put their newfound knowledge to work.

The objectives of the project include:

1. Design and develop displays and programs for Nature Centers' education focusing on meteorology, physical science, and mathematics.
2. Develop a related teacher-inservice workshop to help teachers learn to integrate science and mathematics more effectively in their classrooms.
3. Pilot the displays and programs in the Stokes Nature Center.
4. Assess the learning value of the project and report the results in the science education literature.
5. Provide internet access to the data and learning modules.

## 2. STOKES NATURE CENTER

Stokes Nature Center (Fig 1) is situated at the mouth of Logan Canyon. It is serving as the pilot site for this project. The center is a non-profit nature education facility (see http://www.logannature.org/). It provides field-based science education programs for all ages. The programs include

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- Field programs designed for school field trips, correlated to the Utah State Core Curriculum, including pre- and post-visit lesson plans.
- Saturday family programs: one week per month of nature programs for all ages and another week emphasizes activities for children ages 6-8.
- Winter safety and winter survival programs, designed as special programs for one day or one evening plus one full day in the snowy outdoors on a snowshoe trip. This program is popular with Boy and Girl Scout troops.
- Summer Dipper Day Camp, which is a chance for elementary students to spend a week of summer days exploring Cache County's diverse habitats and wildlife.
- Displays within the Nature Center building, accessible to drop-in visitors during the hours of operation.

Topics for the programs include exploring river water quality by collecting and identifying invertebrates, hands-on ecology, plant and animal seasonal preparations, soil science, tree ecology, geology, and the inner workings and transport of seeds.

Various local schools use Stokes Nature Center to facilitate their teaching of science. The Nature Center receives excellent feedback from excited children, teachers, and parents on their presentation techniques and their methods of integrating the surroundings into their lessons. Programs such as the one presented here are examples of opportunities for the public to learn about science in an informal setting. It reaches people from all walks of life. The informal nature of the Center allows children to learn without the usual pressures of schoolwork, thus being accessible to students who may not be traditional learners.

FIGURE 1. Stokes Nature Center in Logan Canyon

While there is much that is positive about the efforts of the Stokes Nature Center and other centers like it, we believe a weakness is that there is a general lack of emphasis devoted to physical science and mathematics. Of course, physical science and mathematics are also intrinsic parts of the natural world. One example of a physical science that is quite amenable to the type of learning that goes on in a nature center is meteorology. The science of meteorology is also an excellent example of a science that deals with data in a very mathematical way, thus being a wonderful opportunity to present mathematics as part of nature.

## 3. METEOROLOGICAL DATA COLLECTION

To meet the goals of providing enhanced mathematical and physical science curriculum, we are concentrating on working with real-time weather data. We plan to go beyond the typical cloud and sky observation and teach students to evaluate data to determine the "why's" of how the weather works.

The first step of the project is to obtain equipment to measure meteorological variables. This is done in two ways. First, a weather station is being sited at the nature center. Campbell Scientific, based in Logan, is one of the primary sources of weather stations in the United States. They are willing to donate equipment to Stokes Nature Center and will provide manpower to set the equipment up within usual specifications. They additionally have four other weather stations sited in Cache Valley with data accessible online. Siting the weather station requires the co-ordination of the university investigators, Campbell Scientific Personnel, nature center staff, and the US Forest Service who owns the land on which it will be sited. Variables to be measured include air temperature, relative humidity, wind speed and direction, barometric pressure, precipitation, and solar radiation. Telephone lines provide communication with a data logger that includes software programs to retrieve the data and graphically display it.

The second type of data acquisition will be via hand-held monitors that groups visiting the nature center can take into the field. These devices will include thermometers, hygrometers, and manometers. These are hardy in nature so that they will be usable by many groups over a long period of time. There are also observational tools, such as binoculars and a camcorder to record clouds and interpretative material.

Obtaining the data is merely the first step to using it as a teaching tool. The second step will be designing programs for students and teachers as well as appropriate public displays for the center. These programs will not emphasize the data as much as its interpretation, and thus its meaning, to the weather and climate of the canyon.

## 4. EDUCATION MATERIALS

Obtaining weather data is only the first step of providing Nature Center patrons with opportunities to assess the physical and mathematical basis of meteorology. The project provides educational opportunities centered around the way people typically visit the nature center. Displays will be provided that are useful to anyone visiting the Center. But in addition, programs for children and teachers are provided to teach them how to look at the data, assess it, and learn how to think about it in a quantitative and inquiry-based direction.

Displays in the nature center are of two types. The first type are based on the weather station monitors. A visual display of the current and historical values of the measured data are available. Plots are of various types, ranging from a simple time series that shows hourly changes, to very long-term displays, such as histogram plots of a variable, such as temperature, which helps interpret the climate of the region. A laptop computer is available to compare the local data with the other stations throughout Cache Valley. The second type of display will be less data oriented and more interpretive in nature. It will explain the weather and climate in Logan Canyon and what makes it unique. The weather can be related to the topography of the canyon. Displays can be viewed either by school groups or informal visitors.

Children's programs are being developed to facilitate learning by school groups that visit the Center on field trips or summer camps. These programs are geared to augment the Utah Core Curriculum for Fourth Grade under the topic of Atmosphere and Weather. The weather station data are used to observe the current weather variables (temperature, humidity, wind speed and direction, solar radiation, and precipitation). In addition, students are able to observe time series of the data and use them to interpret the current and past weather. Longer time series will show the climate of the Canyon. We are developing various displays that will demonstrate the data in interesting ways, including charts such as histograms or pie charts, which demonstrate the utility of mathematical analysis of physical observations. A laptop computer is dedicated to the program to allow data analysis and connection to the internet so that other local weather stations can be observed. Campbell Scientific also has weather stations located elsewhere in Cache Valley. Students will be able to compare these data under various situations. They will be able to observe geographic and orographic effects through this comparison. The students will be given software tools to analyze the data and build a story of present and past data to explain the weather they observe. The students will then be taken into the field to do their own sampling of meteorological data. Thermohygrometers will be provided to groups of students so they can observe local variations of temperature and humidity around the Center locale. They will observe clouds and weather patterns using binoculars and record their observations in notebooks and on videotape. They will be provided with cloud field guides to identify current conditions. They will be asked to interpret these conditions and use them, together with the data, to make a short term forecast. Children will develop a presentation of their findings and forecasts to present to the group. During wrap-up, staff will discuss the most recent National Weather Service forecasts and how they relate to observed conditions. Teachers will be provided follow-up materials so that they can further discuss the results of the local forecasting on subsequent days. In addition, teachers will be given the tools and encouraged to practice the observing and forecasting techniques with their classes over a longer period of time. In this manner, students will learn how to integrate and interpret their observations, fitting them into a model that can then be used to understand the world around them.

Additionally, a Teacher in-service workshop is being developed to help teachers learn to extend the lessons learned at nature centers when they return with their children to their classrooms. Teachers in the one-day workshop will be taught instructional techniques for not only capitalizing on the hands-on learning opportunities available for their students through nature centers, but also how they themselves can create learning situations effectively integrating science and mathematics. These activities will capitalize on the natural environments found around their schools and throughout their communities. The pedagogical focus of the workshop will be to reiterate the fact that students can gain significant science and mathematical knowledge when the learning situations are predicated on solving realistic problems found in their environment. As students acquire scientific and mathematical knowledge through their study of meteorology, they will learn to apply what they know to analyze and predict weather conditions and relationships. It is expected that the students will not only gain in their understanding of weather phenomena but will also learn to how the mathematics and scientific concepts being learned are relevant and applicable to their daily lives.

## 5. CONCLUSIONS

By observing meteorological data and conditions, visitors to Stokes Nature Center will be able to integrate the physics and mathematics of the natural surroundings. In addition, children's programs are being developed for both visiting school groups and for teachers who wish to

develop classroom meteorology units. These programs will be piloted and assessed soon. An environmental education graduate student is assisting the project leaders.

This project is being designed as a model that can then be expanded to other nature centers throughout the state and region. Perhaps with careful development of these educational tools, we can help develop a new paradigm for educating the public in science and mathematics in an informal setting. Achieving these goals will help increase the public's (and particularly school children's) abilities in science-related areas.

Real mathematics and scientific inquiry is also important to help students develop productive views of the nature of mathematics and science. When students understand mathematics and science as dynamic processes, rather than static sets of facts to be learned, they are more successful at inquiry and continued learning.

## 6. REFERENCES

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