2002

Authentic Field Ecology Experiences for Teachers

Marion Dresner
Portland State University, dresnem@pdx.edu

Andrew Moldenke
Oregon State University

Citation Details

M. Dresner, A. Moldenke. Authentic field ecology experiences for teachers. American Biology Teacher Vol.64 (8). 2002. pp. 659-663.

Authentic FIELD ECOLOGY EXPERIENCES for Teachers

MARION DRESNER ANDREW MOLDENKE

We can still help make discoveries about new species and their ecological relationships, even at the beginning of the 21st century. Science teachers have several opportunities to work alongside field biologists and carry out many authentic field studies throughout the United States and abroad. This paper will focus on one teacher field research experience situated in the Pacific Northwest.

Conducting authentic scientific field work involves worthwhile and meaningful experiences in constructing new and meaningful scientific knowledge. This work must be of high quality and be useful to scientists outside of the context of school, typically scientists at a natural resource agency. Teachers who spend time collecting useful scientific data tend to develop an in-depth understanding of the topic, and are usually motivated to continue to deepen their skills and understanding. Their excitement spills over into how they teach; their classroom becomes imbued with renewed enthusiasm. Typically, they use authentic project work with students, where they often see improved student academic performance (Newmann et al., 1996).

Pacific NW State Standards mandate science inquiry, but most teachers have not been taught to teach science using inquiry techniques. Through our four years of experience working with teachers, we have found that most need to participate in a science inquiry project themselves before they can begin to include it in a meaningful way into their own practice. Teachers also need to experience a meaningful authentic field science project for themselves before being capable of providing one of sufficient intellectual quality for their students.

Hands-on learning experiences through project-based activities can lead to broad-ranging benefits for student learning. Evidence gathered from more than 60 schools, collected via site-visits, interviews, surveys, and comparisons on standardized test scores show that students learn more effectively with environmentally-based content (Leiberman & Hoody, 1998). Analysis of academic achievement comparing these programs with traditional ones shows that 92% of students in programs where the environment was the integrative context for learning academically outperformed their peers in traditional programs. These students earned better scores in science achievement tests, were better able to apply science in real-world situations, and had greater enthusiasm and interest in learning science.

MARION DRESNER, Ph.D., is an Assistant Professor at Portland State University, Center for Science Education, Portland State University, Portland, OR 97207; dresnerm@pdx.edu. ANDREW MOLDENKE, Ph.D., is an Assistant Professor at Oregon State University in the Department of Entomology, Oregon State University, Corvallis, OR 97331; moldenka@ava.bcc.orst.edu.

Krupka (2000) emphasizes the importance of fostering a new generation of scientific naturalists. He describes the benefits of ecological exercises on or near the school campus, and for field trips to comparable sites away from the school grounds. This training could provide more widespread support for specific conservation biology issues and support for the maintenance of biological diversity. Middle and high school-aged students who participated in field work in ecology would have a better foundation for future career choices in the biological sciences.

The forests of the Pacific Northwest are diverse, containing many unexplored ecological processes and organisms. The opportunity to make a direct contribution has been extended to teachers through programs like Teachers in the Woods. During a six-week summer program, each has a significant experience doing monitoring work alongside field biologists. The teachers go on to create an authentic field project for their students. One outstanding example of authentic field research work involving teachers has been projects monitoring for diversity of terrestrial invertebrates.

Terrestrial Invertebrates

Invertebrate monitoring has been widespread in Europe for the past 20 years and has become increasingly important in North America. Invertebrate monitoring is used as an independent assay of widespread long-term ecological processes. For example, a change in species composition can indicate a significant decrease in water quality, which subsequently can be more carefully checked. Invertebrates are also used as a surrogate to indicate fine-scale problems; since they are both ecologically diverse and respond rapidly to change, they allow for the rapid assessment of different alternative land management practices. In forests, all management procedures from clear-cutting, establishment of riparian reserve buffers or preservation of old growth have strong effects on ecosystem biodiversity. Invertebrate monitoring is often the easiest method to observe decade-long recovery periods. The abundance, diversity, and natural histories of species of soil-dwelling arthropods are easy for teachers and students to monitor, and it is critical to document their responses to land management techniques.

In the forests of the Pacific Northwest the relationship between soil health and forest policy is recognized as being of particular concern in the Klamath Region of southwestern Oregon and northwestern California. Not only is it known that species, both plants and arthropods alike, are far more likely to be of limited local distribution and hence more likely for extinction in this region, but conifer species are far more physiologically stressed and soil conditions are far more fragile. Certain logging practices have been shown to upset soil ecology and result in irretrievable ability to grow trees on previously forested sites. Soil ecological relations between the myriad of fungi, bacteria and invertebrates are extremely complex. Invertebrates are currently being monitored as sensitive indicators of overall soil health with the help of local science teachers.

The Northwest Forest Plan, the dominant management guideline for Pacific Northwest National Forests, has radically reshaped how forests are to be managed. Instead of managing for a single species, such as for Douglas fir or spotted owls, the plan is based upon understanding the forest as a complex ecosystem. The health of the ecosystem is dependent upon the integrity of numerous fundamental processes, such as nutrient recycling. Since arthropods participate in or drive most of these processes, it is critical to monitor them. Their presence can indicate fundamental characteristics of ecosystems change far more rapidly than botanical monitoring can reveal. Since funding for long term research projects such as this is extremely limited, teachers who receive training through the Teachers in the Woods program are allies in helping gather this valuable information in participating national Forests throughout the Pacific Northwest.

A pitfall trap method is used to collect invertebrates. The traps are set out in a grid of 12 traps placed as deep as possible within the forest stand so as not to capture "forest edge" species. Relevant ecological information about the site, such as soil duff thickness or canopy closure, is collected. Once the traps are set, they are left out for about two to three weeks. Then, the traps are collected and the invertebrates are sorted out and grouped according to obvious physical similarities. Even advanced elementary students can sort them to the family level and keep track of the number of each type. Experts are necessary to correctly sort them into species. A web site has been created to help sort out terrestrial invertebrates: www.ent.orst.edu/comtesa.

Teachers in the Woods

The Teachers in the Woods program, funded by a grant from the National Science Foundation, provides training for middle and high school teachers and places them in a variety of monitoring and research projects working alongside biologists in National Forests, National Wildlife Refuges, and National Parks. This experience allows them to expand their role from educator to becoming a contributing member of a team of scientists making a direct contribution towards better forest management practices. Once having this field-based experience in ecosystem functioning, teachers have the knowledge, motivation, and skills necessary to develop their own projects for their own students.

Project staff provide teachers with continued contacts and support to help them implement their own project.

Most of these teachers have developed their own student project involving authentic field-based data collection. Many of these projects involve the participation of a local natural resource agency or citizen's group, such as the Bear Creek Watershed Council and Metropolitan Portland's Regional Greenspaces and Portland's City Parks. For example, a Portland, Oregon high school class monitored a rare plant growing at a popular mountain biking destination. Students designed and implemented a monitoring plan and presented a Conservation Strategy to the local parks department. A middle school class in Grants Pass, Oregon studied tree growth on the school grounds and tried to find correlations between growth rate and atmospheric factors, such as climate. A Vancouver, Washington high school class monitored the nitrogen levels in forest soils before and after a controlled burn. A middle school class in Eugene, Oregon studied the factors governing changes in color patterns on pacific tree frogs to determine if these patterns could be used to identify individuals using photographs. A high school class in Helena, Montana studied the effects of grazing on the grassland ecosystem.

Many of these projects were organized to allow small groups of students to conduct variations within the major theme of the study. Allowing student choice within the context of a class project helps them build on their strengths and interests. As is suggested by educational researcher Linda Darling-Hammond (1996), students were encouraged to feel more confident and capable in school by allowing them opportunities for practice, debriefing, and making revisions because their work "counted" within the scientific community.

Case Studies of Two Teachers

Susan, a middle school teacher from Portland, Oregon, spent her four weeks of summer research primarily at the Randall Research area in northern Gifford Pinchot National Forest working with three ecologists. Her summer experience was varied and deep enough to serve as a reservoir for the entire school year. Her experience conducting long-term terrestrial invertebrate studies helped her to develop her own passion for the work and forge long-term professional contacts she now continues to use. She also learned about the importance of consistency in data collection and how to troubleshoot when problem arose. She chose to do a comparative study using terrestrial invertebrates with her students as a vehicle to instill an interest in life-long learning.

Susan's students learned the steps of science inquiry, especially how to formulate a good question. Each student carried out background research on a chosen species of invertebrate. They practiced measuring transects and learned field observation skills. They then set out a series of pitfall traps in three comparable locations: their school yard, a second growth forest, and an old growth forest. The Forest Service ecologists with whom Susan worked during the summer went out in the field with her students. After the traps were collected, students sorted them out by families. Another expert helped her key them out to species.

Gary, a high school teacher from Salem, Oregon, spent his four weeks of summer research working with ecologists at the H.J. Andrews Long Term Experimental Forest. He conducted his own research project centering on the design and implementation of a study to compare the terrestrial arthropods in old growth and mature stands of mixed conifer forests. Additionally, he also worked with a research team that was studying the distribution of Pacific Giant salamanders and a team that was studying long-term characteristics of old growth ecosystems.

Gary was well equipped to take the next step with kids. He states that the summer experience prompted his involvement with a local forest ecosystem and enabled him to develop field skills that facilitated his student project. Through the program, he made a link with a Foundation resulting in a grant of $2000.00 to pay for field equipment. His students helped develop an environmental site report on a 10-acre parcel of forestland, recently donated to the State, in west Salem. Students measured and counted species of trees, measured canopy closure, and assessed the site for other old growth characteristics. Then, they inventoried animal and invertebrate species. The site will eventually become a nature study area for school groups.

Gary felt that along with some better understanding of forest ecosystems, this project afforded students the opportunity to make a real difference in their communities. Many of the kids commented that it was great for them to work on setting aside something of real value for future generations. Some said that the site would, without their help, likely get sold for profit and then be paved over for a new housing development.

Some of the other teacher-participants have voiced the following benefits of their summer internships in national forests:

"Seeing many field techniques in practice and developing confidence in teaching some of these, such as running a transect, because of continued practice, helped me feel more comfortable taking the kids in the field. I didn't have the required knowledge to teach this way before. Although I am still far from expert, I know how to find the people to ask." (Washington teacher)

"The naturalist in me was awakened and motivated to learn more. We went out to count bats. The biologists working with us gave us many things to think about, as overhead the nighthawks were calling. We sat almost silent for almost an hour; we were entranced, completely willing. If only I could create that kind of desire in my class." (Oregon teacher)

"I have a new understanding about science, and as my students pick up on this, their own genuine interest will show and spread. Kids feed off of the way their teacher feels about their subject." (California teacher)

Teacher Survey Results

Formal surveys were conducted with 120 participating teachers over a period of three years. A majority of teachers reported that they felt an increased motivation to do field work as a result of their summer experience. They had more confidence in their own level of scientific knowledge and field skills, and had a strong sense of connection with other professionals. All participants reported an increase in their level of personal field science skills.

Teachers also experienced fundamental shifts in their understanding about teaching science inquiry. Less than a third of participating teachers were comfortable with their skill levels at beginning of the summer. By the end of the survey period, all teachers had shifted to a higher level of proficiency in teaching science inquiry. At first, the teachers saw themselves as being relatively incompetent in carrying out the work. As the summer progressed, their understanding of how to conduct the work increased to a level of competency. This insight enabled the teachers to be better equipped to help their students achieve a similar breakthrough in doing their own authentic field projects.

Nearly all of our participants developed and implemented field science projects for their students. A total of 94% of participants reported that they had either instituted or improved upon a student field ecology project at a site on or near their school as a result of their participation in this project. Many of these projects were enduring; teachers continued to improve upon them over subsequent years.

Student Gains from Teachers in the Woods

Eight categories of field work and science inquiry skills, each using a six-point scale, were developed to help evaluate the benefits to students in doing a field project. The field skills were: using equipment and appropriate methodology to carry out the investigation, field process skills, conceptual understanding of purpose of data collection, and appropriate social skills to perform tasks. Science inquiry skills included: content and concepts, questions, design, and analysis, interpretation and reporting of data. Scoring criteria for each of the six points were developed based upon overt student actions, such as demonstrating sound practice that generates useful data or explaining in their own words how the data collected relates to the investigation.

In an initial study using this performance-based tool, five teachers assessed changes in their students' skills. A total of 155 students was assessed. Student scores increased, especially in the ability to apply scientific concepts, to develop field research questions, and to design a field investigation. Students' science inquiry skills also showed significant improvement, especially in applying scientific concepts, formulating of field research questions, and designing a field investigation. More than 60% of students surveyed had improved their skills in all eight areas. Eighty percent had improved their skills in six of the eight areas, including all four field skills and two science inquiry skills (framing and designing an investigation and collecting and presenting data).

The Need for Teacher Training

What preparation does a teacher need to be able to carry out a successful student field project? Teachers need to become more flexible in his/her practice to encourage successful student field work. There are no known existing "cookbook" curricula detailing the sequence for a teacher to implement a "real-world" environmental monitoring or restoration project. In addition, teachers must become comfortable with the messiness that such long-range work entails. Teachers need a deeper knowledge of the subject matter than is typically assumed with "cookbook" types of printed curricula (Goodland, 1990). They also need firsthand background knowledge of field ecology and an adequate set of field skills themselves before adequately taking on the task of training students to do so.

In authentic project work, superficial recall of information is not adequate. Instead, students must apply what they learned to new situations and show their competency in a complex performance task, such as carrying out a field research project. Teachers need to change their practice from being only dispensers of knowledge to being providers of situations from which students can derive their own understanding. The teacher becomes more of a coach or mentor who encourages students to do the active work of science inquiry. This presumes the teacher already understands how inquiry operates, and can train students in successive stages to undertake the rigorous challenges involved.

After teaching with student field ecology projects for the first time, and after a cycle of evaluation and reflection, teachers achieve a new comprehension of the value of teaching this way. Eventually they derive more effective strategies for generating greater student understanding (Schulman, 1987). Teachers need new tools to access student thinking. For example, teachers who are involved in a new learning situation themselves might experience their new insights as their students would. Teachers who have themselves struggled to learn how to carry out a field research project and, eventually, become competent, can recognize their own growth as learners, enabling them, among other things, to help their students achieve similar understandings and new competencies.

Opportunities for teachers to share what they know collaboratively, discuss what they want to learn, and reflect on the content and process they are learning puts teachers into a professional community extending beyond the traditional limits of the school (Darling-Hammond, 1996). Having professional contacts with field biologists and enduring contacts with like-minded teachers is also valuable.

The Teachers in the Woods program is currently open to experienced middle and high school teachers throughout the Pacific Northwest and, beginning in 2003, to teachers in Colorado, Wyoming, and Montana. The project web site is: www.cse.pdx.edu/forest. Contact us at dresnerm@pdx.edu for more information.

A sampling of some other authentic field research experiences for teachers includes:

1. San Francisco State University Wildlands Studies Field Explorations sponsors national and international ecosystem studies opportunities. Their web site is: www.wildlandsstudies.com/ws.
2. University of California Research Expeditions Program offers field work opportunities in the US and Canada, Africa, Central and South America, Asia and Europe. Their web site is: http://urep.ucdavis.edu/.

Recommendations

Over the past four years, we have developed the following set of recommendations in starting a field ecology project based upon interviews with participating teachers. We suggest that teachers begin with a small piece of the "whole" and recognize that the work will be a multi-year process. This is due to the need to first learn about the site, develop proficiency in the use of monitoring protocols and use of field equipment, and the need to develop a meaningful, engaging project that uses authentic methods and represents a "whole" piece of scientific work. Field project sites that are close to the school help to alleviate limitations in scheduling and funds for transportation to a more remote site. Collaborations are important. Partnerships with practicing field scientists provide legitimization to the project and provide necessary expert advice to the students. Having opportunities for reflection and collaboration with other teachers helps to alleviate some of the professional isolation felt by innovative teachers.

References

Darling-Hammond, L. (1996). The right to learn and the advancement of teaching: Research, policy and practice for democratic education. *Educational Researcher, 25*(6), 5-17.

Goodland, J. (1990). *Teachers for Our Nation's Schools.* San Francisco: Jossey-Bass.

Krupka, J. J. (2000). The importance of naturalists as teachers and the use of natural history as a teaching tool. *The American Biology Teacher, 62*(8), 553-558.

Lieberman, G. & Hoody, L. (1998). *Closing the Achievement Gap: Using the Environment as an Integrative Context in Learning.* Poway, CA: State Education and Environment Roundtable. Science Wizards.

Newmann, F., Marks, H. & Gamoran, A. (1996). Authentic pedagogy and student performance. *American Journal of Education, 104,* 280-312.

Schulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Education Review, 57*(1), 1-22.