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Developing the Talents of Teacher/Scientists

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Going on an expedition enables teachers to become better scientists and researchers and, thus, better classroom instructors. Teachers have the opportunities to go on exotic field trips around the world as amateur research assistants, do hands-on research in their own backyards, or vicariously experience another scientist's work via the Internet. A list of annotated Web sites invite teachers to explore the possibilities of doing scientific research as part of a team internationally (e.g., NOAA's Sustainable Seas Expedition), locally (e.g., The Cornel Lab of Ornithology's Project FeederWatch), or virtually (e.g., The Earth Watch Global Classroom). One teacher's experience doing research in these three venues is testimony to how undertaking these types of authentic scientific research improves student instruction and learning.

One of the best things teachers can do to develop the talents of young scientists is to do science themselves. Teachers need to practice doing practical science research, with the emphasis on doing if they are to impart the joy of science to their students. Linguists tell us that the best way to learn a language is through immersion. Go to a foreign country, live there, and speak the language daily. Likewise, if teachers want to become better scientists or researchers, they need to go on an expedition and immerse themselves in the day-to-day language of science and research. By conducting this type of personal investigation, teachers can travel to locations worldwide, learn new skills, make new friends, contribute to the growing knowledge about planet Earth, and bring back valuable insights about teaching science to their classrooms. Teachers inevitably receive more respect from their students because they not only "talk the talk" about science, but because they have also "walked the walk" as practicing professionals in the field. There are many opportunities now available through the Internet for teachers to be part of a research team in the field.

Part I: Field Research Opportunities

National Oceanographic and Atmospheric Administration (NOAA) Sustainable Seas Expeditions http://www.sustainableseas.noaa.gov/aboutsse/education/education.html

The National Oceanographic and Atmospheric Administration (NOAA) administers the Sustainable Seas Expedition program, which offers teachers two opportunities for professional development: the Teacher in the Sea program and the Teacher at Sea program. Research vessels are available to accommodate teachers who wish to assist oceanographers and marine biologists in research on such topics as ocean floor mapping and shark behavior. One no-frills expedition offered by NOAA is a 3-day trip from Miami to Mississippi towing a plankton net. Teacher/scientists aboard this ship work 8-hour shifts pulling up the tow and examining what they find. The expedition is not about books or coursework, just getting your hands wet and learning first-hand about what's in the ocean.

Research at SEA
http://www.sea.edu/sea2000/admission2000/Teachers.htm

SEA Seamester's 6-week program is an oceanographic research experience for middle and high school teachers. It gives them the opportunity to explore the oceanic environment while learning about the scientific research process firsthand. The program uses a sailing research vessel as the platform utilizes the expertise of oceanographers from the Woods Hole scientific community. Participants in Research at SEA learn how research scientists pose and attempt to answer scientific questions. The goal is to enhance the teacher's ability to bring investigative learning into their classrooms.

Earth Watch Institute
http://www.earthwatch.org

Earthwatch is another organization that seeks out volunteers to participate in research trips, from the ruins of ancient Pompeii, to the zebras of Kenya. Participants support research scientists in their field work collecting data. So far, 3,500 volunteers have worked with 120 research scientists in more than 50 countries all around the world.

The JASON Project
http://www.jasonproject.org

Another excellent program that solicits both teacher and student volunteers is the JASON Project. Dr. Ballard, famous for discovering the *Titanic*, has for the last 12 years been going around the world on expeditions that are broadcast live back to school audiences. Regular students and teachers who have an interest in doing science on a remote site help with the nuts-and-bolts work of assisting field biologists, oceanographers, and technicians on these expeditions.

The Amazon/Andes Rainforest Workshop
http://www.birds.cornell.edu/cfw/classroom/amazon_workshop.html

The Amazon/Andes Rainforest Workshop allows participants to become involved with field research that is currently underway in the area. Participants explore a variety of topics such as rainforest ecology, rainforest conservation, tropical mammals, neotropical insects, tropical birds, and medicinal use of plants. The National Science Teachers Association and the National Biology Teachers Association cosponsor the workshop.

The University of California at Berkeley's
Research Expeditions Program
http://www.berkeley.edu

University of California
Research Expeditions Program (UREP)
http://www.extension.ucdavis.edu/urep

University of California, Irvine
Center for International Education
http://www.cie.uci.edu/iop

The University of California Research Expeditions Program combines a University of California research team with volunteers to undertake research in variety of areas, including archaeology, animal studies, geology, arts and culture, and environmental conservation. Current research expeditions include prehistoric settlers of Lake Titicaca in Peru and saving Orinoco Geese in Venezuela, gray whales of the Pacific Northwest in British Columbia, and ancient reefs of the Outback in Australia. The program at Irvine offers teachers the opportunities for internships, volunteer positions, field research, and teaching overseas.

Conservation Education Diving Awareness
Marine Research (CEDAM)
http://www.cedam.org

A special mention must be given to CEDAM, which stands for their interests in Conservation, Education, Diving, Awareness, and Marine Research, headed by underwater naturalists Rick and Susan Sammon. This organization assists marine science and research projects by paring marine scientists who need assistance with their research in marine biology and marine/terrestrial archeology with volunteer divers who want to participate in scientific research. Current expeditions include a reef survey in Dominica, West Indies; Nudibranch study in the Fiji Islands; and grouper tagging and observations in the Turks and Caicos Islands.

Bermuda Biological Station for Research., Inc.
http://www.bbsr.edu

Located in the mid-Atlantic, this station for research in biology and zoology offers courses, workshops, a library, and dive facilities. The focus is on oceanography and coral reefs.

The Center for Integrating Research and Learning
at the National High Magnetic Field Laboratory
http://ret.magnet.fsu.edu

The Center for Integrating Research and Learning at the National High Magnetic Field Laboratory offers a program entitled "Research Experiences for Teachers." Funded by the National Science Foundation, the 6-week residential program provides K–12 teachers with the opportunity to participate in real-world science research.

EcoTeach
http://www.ecoteach.com

This ecotourism company provides sea turtle research tours in Costa Rica for teachers and their students (with 20 students, teachers go free) or teacher-only study tours with university credit.

International Field Studies
http://www.intlfieldstudies.com

International Filed Studies (IFS) is a public, nonprofit, educational organization that promotes and assists teachers with field study programs. IFS functions as a facilitator for educational groups seeking expertise and logistical support. IFS staff members, experienced field instructors, and resource materials are available to assist teachers and group leaders with educational development, site planning, and budgeting for a successful, comprehensive field program. By working with IFS to develop a proposed field study, teachers are able to offer their students high-quality field study opportunities that would not be feasible without such a collective effort.

WhaleNet Teacher Opportunities and Classes
http://whale.wheelock.edu/whalenet-stuff/prof_dev.html

WhaleNet offers teachers professional development field courses in Massachusetts, Quebec, and Bermuda and provides links to many other opportunities across the country.

MarineLab's Introduction to Coastal Marine Ecology of the Florida Keys
http://www.mrdf.org/marinelab_teacher.htm

MarineLab in Key Largo, FL, offers a 1-week intensive field program of subtropical/tropical marine ecology geared toward middle and secondary school science teachers.

NASA's Summer High School Apprenticeship Research Program (SHARP)
http://www.mtsibase.com/sharp

Sponsored by the National Aeronautics and Space Administration (NASA) since its inception in 1980, the Summer High School Apprenticeship Research Program (SHARP) is designed for students who have demonstrated a strong interest in and aptitude for mathematics, science, engineering, and technology. Each year, approximately 200 students are selected to participate in SHARP for a minimum of 8 weeks during the summer. Some of NASA's top science professionals mentor qualified students while conducting cutting-edge research and working on state-of-the-art equipment.

Part II: Backyard Research

Traveling to exotic locations to do field research is definitely an experience that a teacher will remember and relate to his or her class with enthusiasm. For those who are unable to travel far from home, there are other opportunities to undertake scientific research closer to home.

Cornell Lab of Ornithology
http://birds.cornell.edu

Researchers at the Cornell Lab of Ornithology are enlisting citizen-scientists to help collect data for researchers' studies of bird populations. This collection can be done in a person's backyard or in a teacher's schoolyard through programs such as eBird, Project PigeonWatch, Birds in Forested Landscapes, and Project FeederWatch. Ornithologists use this information to learn what birds are found where and how bird populations might be changing over time. For example, scientists at the lab are tracking the spread of house finch eye disease. This disease causes conjunctivitis in birds, and many die because their poor vision prevents them from finding food and avoiding predators. Thanks to the efforts of citizen-scientists, researchers have been able to track the spread of disease through a wild population of animals for the first time.

National Wildlife Federation's Backyard Wildlife Habitat
http://www.nwf.org/backyardwildlifehabitat

The National Wildlife Federation's Backyard Wildlife Habitat program involves volunteers in creating a certified habitat in their own backyard or in their schoolyard. Citizen-naturalists participate in formal data collecting and monitoring projects to help songbirds, butterflies, and other wildlife.

International Migratory Bird Day (IMBD)
http://www.americanbirding.org/imbd

International Migratory Bird Day celebrates the return of millions of migratory birds to their breeding areas. Individuals,

groups, and schools participate in IMBD by organizing birding tours, conducting surveys, and holding festivals and workshops with the purpose of educating and encouraging others in their community to join in the conservation of migratory birds and their habitats.

National Audubon Society Christmas Bird Count
http://www.audubon.org/bird/cbc

The Audubon Society sponsors an annual hemispheric early-winter bird census during which volunteers count individual bird and bird species. Data provide valuable insights into the long-term health of bird populations and the environment.

4th of July Butterfly Count
http://www.naba.org/4july.html

This ongoing program collects census data on the butterflies of North America and publishes the results. Volunteer participants select a count area and conduct a 1-day census of butterflies sighted. Counts are usually held sometime around July 4.

Monarch Watch
http://www.monarchwatch.org

This outreach program promotes the conservation of monarch butterflies and involves thousands of students and adults in a cooperative tagging study of the monarch's fall migration.

Keeping Track
http://www.keepingtrackinc.org

Keeping Track is research/education project through which volunteers are trained in wildlife track and sign identification either in Vermont or at a local site in a participant's home state. Cumulative date is used to aid local and regional planners in making informed decisions about wildlife habitat protection.

North America Amphibian Monitoring Program (NAAMP)
http://www.pwrc.usgs.gov/naamp

This is a project through which volunteers monitor amphibian populations. Projects include frog call surveys and terrestrial salamander monitoring.

Save Our Streams
http://www.iwla.org/sos

This is a grassroots river conservation program through which volunteers are trained to monitor and restore local waterways. Projects exist in all 50 states. They have an excellent online macroinvertabrate identification program.

Part III: Virtual Expeditions

For people who like to travel in cyberspace, there are expeditions that do not require them to leave the comforts of their living rooms. Online adventures to worldwide locations, as well as to outer space destinations, are possible for both the classroom teacher and his or her students. The following are a few of the many journeys possible.

The Biology Project: The University of Arizona
http://www.biology.arizona.edu

This "Web lab" simulates the potential spread of HIV through a population. Each participant exchanges virtual body fluids with other participants, some of whom are HIV+, and a computer-simulated ELISA (a basic test for the presence of HIV) illustrates the spread of the disease. In addition to the HIV simulation, there is another simulation that is intriguing: DNA Profiling 2001. In this simulation, students learn the concepts and techniques behind DNA profiling used in forensic and paternity labs. They solve DNA paternity tests and missing people's problems.

Education Program @ Earthwatch Institute
http://www.earthwatch.org/education/us.html

This program enables teachers and students to collaborate with scientists doing field research at locations worldwide. Teachers and students who choose not to join researchers in person through the Earthwatch volunteer program can now learn from a distance.

The JASON Project
http://www.marinelab.sarasota.fl.us/~kristen/jason.phtml

The JASON Projects offers a yearlong multimedia interdisciplinary program for students and teachers in grades 5–8. The program integrates video programming, satellite transmissions, classroom instruction, and online activities so that students and teachers may learn through hands-on inquiry.

Journey North
http://www.learner.org/jnorth

Journey North is an Internet-based learning adventure that engages students in a global study of wildlife migration and

seasonal change. Students are linked with scientists who provide their expertise directly to the classroom.

Moonlink
http://www.space-explorers.com

Moonlink is the first Internet-based program that directly involves students in a live space mission. Moonlink students participate in an interactive simulation of the Lunar Prospector Mission and actual data analysis for an 8,700-square-mile section of the moon.

Project Ocean STEWARD Virtual Teacher Workshop
http://www.coexploration.org/sse

The goal of the workshop is to introduce teachers to and educate them in the process (questions) and products (data) of scientific investigations and exploration. Via the Web, workshop participants engage in dialogue with scientists and educators about physical oceanography, geographic information systems, and habitat characterization as they relate to the national marine sanctuaries and Sustainable Seas Expeditions.

Virtual Pig Dissection
http://www.whitman.edu/biology/vpd/main.html

Students dissect a virtual pig and along the way learn about anatomical references, sexing their pig, the digestive system, the excretory system, the circulatory system, the reproductive system, the respiratory system, and the nervous system.

NASA AmesResearch Center Volunteer Opportunities
http://quest.arc.nasa.gov

Located in Mountain View, this interactive education facility uses webcasts and chat rooms to teach kids what happens behind the closed doors of NASA.

SitesALIVE!
http://sitesalive.com

SitesALIVE! is an interactive, multidisciplinary education Web site that connects students in the classroom to adventures, expeditions, and events around the world as they are unfolding.

Part IV: A Teacher's Tale

One of the protégées Dr. Robert Pavlica, founder of the Authentic Science Research Program at Byram Hills High School, not only offers a top-notch authentic science program in his high school, but has adapted the program to the needs of middle school students. Steve Pesick, the science department coordinator for Mt. Pleasant Central Schools in Thornwood, NY, finds he can empathize with students who are undertaking rigorous scientific investigations under the tutelage of a mentor because he was recently awarded the Lloyd Bridges Expedition Scholarship by CEDAM International.

He was paired with Kathleen Sullivan, a researcher in marine biology from the University of Miami, to assist her with her research on groupers in the Caribbean. Steve's tour of duty consisted of spending 1 week aboard the Turks and Cacaos Aggressor with 10 other volunteers. Their research responsibilities were divided between diving in the ocean and working on the deck. Their main job was to bring up groupers to the deck. In order to do this, they had to lower and service the fish traps, bait them with cat food and injured conch, inflate the airbags to raise the cage when a grouper was trapped, and then transfer the grouper on to the deck. Once the fish was on the deck, the second team took over anesthetizing the grouper and then weighing, measuring, and tagging it. Then, they would snip a fin clip for later DNA analysis and dunk the grouper in fresh water to collect isopods to find out what creatures lived on it. Finally, they would return the grouper to the sea. The dive team then escorted the grouper back down to 50 feet and observed the released fish as it readjusted to life under the sea.

In addition to collecting groupers, the dive team also had the responsibility of conducting an abundance and diversity grouper survey of the collecting area. This was accomplished by having three teams of two divers follow three different 50-meter transects and record what was seen in the areas.

The Rewards

Participating in a scientific expedition offers many rewards for the science teacher. The top benefit is the renewed enthusiasm the teacher has for his or her subject. According to Mr. Pesick,

> This enthusiasm, this feeling of rejuvenation will definitely rub off on my students. This enthusiasm comes from the sense that you are doing something that no one else has done before. Unlike some of the science questions in the textbook that are prescribed, presented, and previously solved, no one in the world can tell you what these results will be. Teachers can get their students excited about science by involving them in real-world problems and issues.

In addition, to a renewed vigor for science, Mr. Pesick also brought back to his classroom a sense of what is important for

his students to know about doing science: accuracy and precision, the need for practice, and the need for hands-on involvement. He said,

> Dr. Sullivan constantly stressed that we couldn't give a measurement of "about 36 or 37 centimeters." It had to be exactly 36.4 centimeters. Since groupers grow at the rate of one centimeter a year, this information is necessary for a precise and valid understanding of the fish population.

In order for students to become precise in their measurement or recording of observations, a lot of practice is needed. Before Mr. Pesick and his team went into the water to survey the grouper population, Dr. Sullivan had them practice walking along a transect on deck to catalogue the size and type of groupers that were pictured along the route. A certain standard of accuracy was required before the teams were allowed to dive. Not meeting the standard meant doing it again until they did. Mr. Pesick is now using this concept with his sixth-grade authentic research science class, which is studying birds in the Cornell Lab of Ornithology's Bird Watch Program. Before conducing the bird watch survey for 30 minutes a day for 15 days at their homes, students learn to identify the birds through slides. Mr. Pesick then takes them outside once a week for field practice in identifying the birds at the various bird feeders around the campus. This practice assures a more precise and accurate accounting for the bird survey, which means the surveys will be more valid and reliable.

Measuring and weighing the groupers, dunking them in a fresh water bath to recover isopods, and then tagging them are activities that brought personal involvement and meaning to this research project for Mr. Pesick. To give his students a similar hands-on experience, he had them go out on to the school grounds and collect bugs and insects to learn about classification. With careful, focused inspection, his students were able to categorize bugs as creatures that drink their food because of their pointed mouth and insects as creatures that chew their food because of their mandibles.

Because of Mr. Pesick's experience as a researcher, he has initiated three programs in his science classes that highlight the student as researcher: a research expedition to the coral reefs of Key Largo; Cornell Lab of Ornithology's FeederWatch Program; and H2OWatch, a simulated student-run stream-testing company.

Research Expedition to Key Largo

October 2000 marked the fifth expedition Mr. Pesick sponsored for his students to conduct research on the abundance and diversity of fish on the coral reefs off Key Largo. The overall research question, design, analysis of results, and reporting of results is the responsibility of the Reef Environmental Education Foundation (REEF). His student scuba divers and snorkelers help gather the data needed by REEF. His students follow the protocols established by the organization for identifying and quantifying the different fish on the reef. Data is encoded on a reporting sheet and sent to REEF for inclusion in their worldwide data bank for use by professionals in the field. Students benefit from the REEF encounter by honing their observational skills, learning how to record data accurately, and presenting what they experienced at their annual symposium.

An average of 20 students and parents participate each year. The Saw Mill River Audubon Society has provided grants to several of the students each year to help offset the cost of the trip. Students stay in Key Largo for 5 days. During this time, they receive instruction about the Coral Reef Habitat from Florida Keys National Marine Sanctuary personnel, fish identification classes from the REEF Foundation, a dive to the Jules Verne Underwater Habitat sponsored by the National Oceanic and Atmospheric Administration, as well as water quality monitoring experiences in the bay.

Project FeederWatch

This program introduces students to bird identification, bird behavior, bird habitats, and the protocol used to record observations in the field. For example, one of Mr. Pesick's students had developed this question: "How do birds react to human-made sounds as opposed to natural sounds?" To research this question, she set up a platform feeder outside the science classroom. She attached a speaker to the feeder. A tape-recorder was placed inside the classroom and connected to the speaker. Each morning at 7:00 a.m. for 3 weeks, she played a different tape of such natural sounds as moose calls and canary songs, and then human-made sounds such as the human voice and classical music. She confirmed her hypothesis that birds would not be frightened away by the natural sounds, but would fly away at the human-made sounds. She submitted her results to Cornell Lab of Ornithology's publication *Classroom Birdscope*.

Conclusion

Whether a teacher like Mr. Pesick undertakes science research in an exotic locale, in his or her own backyard, or virtually in cyberspace, the results are beneficial for the students. The teacher's enthusiasm for doing research is extended to the students, who also share in the joy of doing

science. The teacher's expertise is likewise shared with students through insights and procedures that make the path of a novice researcher easier to walk. The old adage that success breeds success is certainly true here. Mr. Pesick has just been selected as a JASON Argonaut and will be assisting Dr. Robert Ballard off the coast of California with teacher and student research on marine and terrestrial ecosystems of the Channel Islands.