CHAPTER 8
GK–12 BEYOND THE USA: FACILITATING INTERNATIONAL PARTNERSHIPS

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A Fellow and Teacher from the University of Tennessee recover lake-sediment cores in Costa Rica.

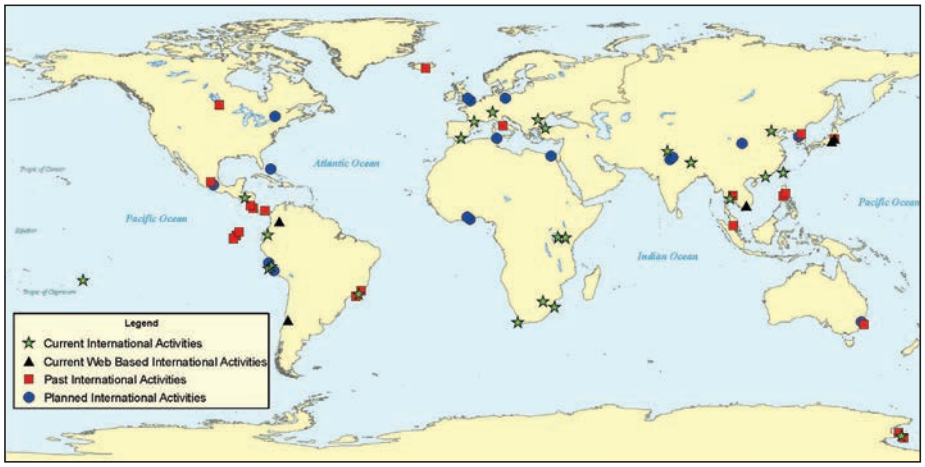
PREVIOUS CHAPTERS HAVE DISCUSSED activities in and out of classrooms in the United States. International experiences and collaborations provide many additional and unique opportunities to GK–12 participants. Through these experiences, Fellows and Teachers can learn about the world, how to function in a global society, and how to develop networks for future collaborations. Preparing a globally engaged workforce is of utmost importance, as was detailed in a workshop hosted by the National Science Foundation in 2006 and titled "Assuring a Globally Engaged Science and Engineering Workforce" (www.sigmaxi.org/global).

This chapter focuses on the advantages of including international opportunities in GK–12 projects. In particular, it looks at benefits for Fellows and Teachers, how to establish international collaborations, requirements and logistics for traveling abroad, and what to do during and after international trips.

Some of the material included in this chapter comes from the Proceedings of the GK–12 Project's Workshop on International Experiences in Science, Technology, Engineering and Mathematics (STEM), a workshop that took place at the National Science Foundation in 2007. Yet, international experiences are not required in the GK–12 approach. Indeed, international experiences are not

CHAPTER HIGHLIGHTS

- International collaborations are important and encouraged whenever possible. They provide multiple benefits for all participants.
- Initial planning to establish the purpose of the trip, the destination, participants, logistics, and collaborators abroad, is essential.
- Make plans in preparation for the trip, but also for afterwards.
- There are multiple models to develop, and multiple funding options for international collaborations.



The map above shows locations of international research by GK-12 projects.

the same for each type of participant, so specific activities should be determined by individual projects. It would be difficult to standardize international experiences for all projects, all Fellows, and all Teachers. Leaving the design of an international component up to each project is simply a creative option.

WHY CONSIDER AN INTERNATIONAL COMPONENT

In its report "Globalization of Science and Engineering Research: A Companion to Science and Engineering Indicators 2010," the National Science Board describes the rapidly changing nature of the science and engineering enterprise and the need to engage in international partnerships to keep the United States globally competitive. The National Science Foundation Strategic Plan (2011–2016) also emphasizes the importance of increasing international collaborations and partnerships. The promotion of international collaboration, the elimination of barriers that prevent collaboration, and the increased need to encourage jointly funded bilateral and multilateral projects are integral components of this plan. As STEM expertise and infrastructure advances throughout the world, it is expected that international collaborations will benefit all participants involved and will result in a larger impact and more innovation in science and engineering worldwide.

> "I have heard people say...that math is a universal language, and after this experience I would have to agree at least to some extent. ...In looking back at my experience in China, I am very thankful to have had the opportunity to participate in this trip...I learned a lot about the similarities and differences between our educational systems, as well as our cultures. As we become more and more of a global society, I believe interactions such as these will help us to have a greater understanding and appreciation for the methods other cultures employ to educate their populations."
>
> —GK–12 Fellow, University of Colorado–Denver, Transforming Experiences Project

How Fellows and Teachers Benefit from International Experiences

Connecting Fellows to researchers and academic and industrial institutions abroad will increase employment options for the Fellows as well. Connecting Teachers to both Teachers and students in other countries will promote STEM learning in the United States. Exploring teaching methods in other countries could promote exchanges on multiple levels and will encourage the use of new technologies and cybertools. The practical reasons for international collaborations include having access to items, equipment, or facilities not available within the native country, focusing on research related to specific regions of the world, and having access to particular data. In addition, experiencing other cultures is a way to broaden one's perspective.

Although global engagement should happen at all levels of education and for all participants involved, the NSF GK–12 program supported mostly project directors, Fellows, and GK–12 Teachers traveling abroad.

Including international experiences for Fellows and Teachers may bring benefits, but also can present some challenges, such as language barriers, culture clashes, and logistics related to visas and permits. Some of these challenges may be overcome with careful planning and close communication with foreign counterparts.

Models of Financial Support for International Activities

There are a number of support models to expand a GK–12 project internationally, primarily as a result of the variability of each university's GK–12 project implementation. The main goal of the international component was to support Fellows' research experiences. However, several projects involved Teachers, and some established connections with K–12 schools abroad. Among GK–12 projects, two main modes of support can be distinguished:

- The NSF GK–12 program provided supplemental funding to GK–12 projects for international activities. Funding was awarded through a competitive process and was also used to involve Fellows and Teachers in the international experience.
- The GK–12 project did not provide supplemental funding, but instead offered a platform for an international experience to operate efficiently.
- The GK–12 project provided a flexible platform for graduate students to develop initiatives at their host schools.

GK-12 projects included experiences in several continents and countries, including Antarctica, Peru, Japan, Thailand, India, China, Tanzania, Panama, Kenya, France, Tahiti, Honduras, Tunisia, Egypt, Poland, Hong Kong, and South Africa. Each trip had a different research focus and target audience, but there were a number of commonalities.

Developing an international partnership is a nontrivial task, as there are many factors to consider that do not arise with the formation of domestic partnerships. If all parties have confidence in the proposed international project, the experience can be extremely enriching for all involved. Anecdotal evidence from previous international projects suggests that such partnerships foster the exchange of important ideas and the development of new resources that can be shared with colleagues across multiple disciplines. At the end of this chapter are short examples.

INITIAL PLANNING

The first step in developing an international collaboration is to identify the purpose of the trip, the country or countries to visit, the potential participants and their foreign counterparts, and the timing of the visit. (Table 8.1 provides a checklist of materials and information for participants before and after the international experience.)

Identify What, Where, Who, and When

The choice of country and specific area within the country will depend on the purpose of the trip and previous collaborations developed by either the university or particular researchers. It is advisable to take advantage of contacts already established. It is crucial to establish direct, personal contact with an individual and institution in the host country early in the development of the project. If there are no previous contacts, preliminary visits can be conducted if the budget allows. These trips serve to develop a level of confidence between the project partners and to explore needs and logistics.

The selection of participants will depend on the goals and format of the trip. How many Fellows and how many Teachers are needed? Will the trip include K–12 students? What are the specifics of the selection process, and will it be competitive? Who will make the selection? What financial support is offered to the participants, and what do they have to provide? What are the reporting requirements for participants?

The attitude of the Fellows' research advisors is an important ingredient in the overall success of the experience. The Fellows should be encouraged to brief their advisors frequently on the goals and duration of the trip and to present a plan for maintaining progress in their graduate degree projects. Ideally, the research advisors will see the value of the trip and perhaps offer advice and contact information.

Define the Purpose of the Trip

Major goals for GK–12 international trips include (1) providing research exchange and collaboration

BENEFITS OF INTERNATIONAL EXPERIENCES

For Fellows

- Learn how research is conducted in other parts of the world.
- Increase adaptability, to work more effectively with scientists who may define and resolve problems differently.
- Establish more extensive networks and increase linkages for future research.
- Learn techniques and have access to resources not available at the home institution.
- Experience the teaching and learning of science in K–12 schools abroad.

For Teachers

- Establish international contacts and lessen professional isolation.
- Experience classrooms abroad and learn new or different ways of teaching.
- Witness successes and challenges of STEM education in different countries.
- Benefit K–12 students at a global level by exchanging ideas and sharing experiences.
- Connect with researchers abroad and possibly conduct research with them.

experiences for Fellows; (2) providing research experience for Teachers; (3) having Teachers and/or Fellows visit STEM classrooms in K–12 schools; and (4) learning about the people, culture, and everyday life in the host country. There are a number of possible organizational schemes for a trip, including the following:

- Individual Fellows are paired with individual researchers at specific universities in the host country. This arrangement allows each Fellow to achieve a deep and specific experience related to a project and to collaborate with a particular researcher.
- Fellows form a single group and the project experience is shared among all. This format may allow for a deeper project impact, but it may leave some Fellows with a suboptimal experience.
- Fellows and Teachers collaborate in a research project with local researchers and connect with local schools. This experience may allow both Fellows and Teacher to experience research and learn about the K–12 system in the host country. If time is sufficient, this scenario might be ideal, but if time is short, it may be difficult to accomplish all planned activities.

The university and K–12 system in the host country, the duration of the trip, and the ease of travel in the country will influence which approach is used. Formats used by other groups, including the examples given at the end of this chapter, can help inform these decisions.

Consider Travel Arrangements

Many universities in the United States and abroad have offices that handle international arrangements for faculty and students. This resource shouldn't be overlooked when travel logistics are considered.

Obtaining visas and making sure that passports are current can be a lengthy process. Start early! Ticketing will involve many phone calls and emails with a travel agency, often the one approved by the sending institution. If possible, visit the travel agency to put a face to a name; the experience is valuable. Consider the requirements for in-country travel. Do vans make sense, or is it more reasonable to use rail? What is the bus system like, and how expensive is in-country airfare? In many instances, it will be worthwhile to establish a relationship with the destination country's embassy, which may be able to answer travel questions directly or identify the proper resources.

> "Global scientific collaboration expands the pool of knowledge that belongs to everyone and serves as a tool to improve health, security, and opportunity throughout the world."
>
> —Subra Suresh, Former Director, National Science Foundation

Lodging considerations will involve determining how convenient the hotel is to the sites to be visited, the price of the hotel, the neighborhood surrounding the hotel, and safety. Are there alternatives to hotels that might make sense for the group, such as hostels, apartments, university housing, or staying with local host families?

Contact the office of risk management on campus and the campus police early in the planning process. Develop a list of emergency contacts for each person going on the trip, and as planning proceeds, supply each one with a list of hotels and dates. Participants may wish to register with the U.S. State Department SMART traveler project (https://travelregistration.state.gov/ibrs/ui). Also, participants will need to review their health insurance plans to determine what will and will not be covered abroad. Emergency health evacuation insurance is available to students and full-time professors at a reasonable rate through an International Student Identification Card (ISIC) (http://www.isic.org). Information about vaccines, as well as other health-related information, can be obtained from the World Health Organization (http://www.who.int/en) or the Centers for Disease Control (http://www.cdc.gov).

Cell phones may be unlocked for international use by cell phone providers, and SIM cards purchased in the host country make it possible to obtain better rates. Internet access may or may not be available at hotels. In some areas, such as Europe, it might make sense to purchase computer devices that allow for mobile Internet access. Although the objectives of the trip might not involve extensive Internet access, Fellows (and Teachers) will want to keep up with their social networks, contact family, and maintain communications with their advisors. Much of this communication can be done inexpensively with Google Chat, Skype, or other Internet-based communication tools.

A preliminary budget based on the proposed project activities should be drafted. This will include a substantial portion for airfare and in-country travel. Questions to ask include: How will accommodations be managed? What are the costs for visas if needed?

Will the project cover vaccinations if required? And Will there be a contingency fund to meet unexpected expenses?

Include a Brief Evaluation Plan

Evaluation can help establish whether the goals and objectives of the trip were achieved. GK–12 international components usually rely on trained evaluators for this purpose. The evaluator may be internal or external to the home institution. Evaluation methods include pre- and post-surveys and interviews of participants, reviews of items such as participant travel logs and planning documents, and direct observation of project activities. Perspectives from the host country and from graduate research advisors, obtained through open-ended questionnaires or surveys, can be valuable as well.

Consider Sources of Funding

Of primary concern is the resolution of funding issues for the trip. First, communication with foreign counterparts prior to traveling is necessary to establish connections between potential participants. There are many avenues to investigate in addressing the issue of funding for an international experience. It may be possible to secure funding through university-to-university partnerships, nonprofit organizations, governmental agencies, or special-interest groups. Even if funding is unavailable, it is still important to develop connections with these sources, both domestically and internationally, as they can provide information and infrastructure. Although funding travel may be the primary implementation concern, obtaining reliable information and an effective infrastructure system is necessary for successful implementation; the value of reliable information and infrastructure cannot be underestimated.

Several sources should be considered for funding international trips. Some researchers already have ongoing international collaborations. Projects might consider linking with these enterprises to include Fellows and Teachers. Some federal agencies offer supplements or have projects aimed specifically at funding international activities. For example, NSF's Office of International Science and Engineering offers the East Asia and Pacific Summer Institutes to support students traveling abroad for the summer. This experience can serve as an initial way to establish links with potential collaborators in the future. The USDA National Institute of Food and Agriculture International Science and Education Competitive Grants Project funds projects in a variety of research areas, including biotechnology and genomics, education, environment and natural resources, and food and nutrition.

Private companies with business activities in the country or area of interest also may provide funding. Another promising source of funding can come through nonprofit, nongovernmental organizations or other philanthropic organizations: Contact both local and national organizations. National Geographic sponsors a "Young Explorers Grant" project that may be appropriate under some circumstances. Funding for travel to countries with reasonably robust economies may be available from organizations or businesses in the host country. For example, the German Academic Exchange Service (*Deutscher Akademischer Austausch Dienst,* or DAAD) provides support for American students to travel to Germany.

Table 8.1 International Experience Checklist

Pre-Departure
Assist participants with travel and medical documents
Arrange travel logistics as far in advance as possible
Establish contacts with foreign counterparts
Offer language and cultural training for participants or arrange for translators if necessary
Provide exact project location and information on the key points of contact
Gather permits required for collecting samples
Convey requirements, responsibilities, expectations, and anticipated outcomes
Have details for medical and travel insurance
Provide emergency contact information for all as well as location of nearest medical facility
Distribute maps, travel itinerary (flight numbers, critical dates, hotel information
Outline financial considerations
List travel recommendations (what to avoid, how to protect travelers, etc.)
In Country
Provide on-site orientation
Encourage participants to present their research
Organize regular group meetings of participants
Maintain contact with the home institution through blogs, Skype, emails, etc.
Return
Disseminate and share experiences broadly
Follow up and maintain linkages with foreign counterparts to keep the collaboration going

DURING THE TRIP

Trip participants will benefit from regular group meetings once they arrive in the host country. To gather participants for meetings, consider renting a small conference room in the hotel where the group is lodged. Other meeting formats might involve simply getting together at the start and end of the trip. To share experiences with partnering classrooms back at home, some participants stay in regular communication with the Teacher and K–12 students through email or blogs. A website that highlights trip activities is also a good way to stay in touch with GK–12 partners.

AFTER THE TRIP

Upon their return, many participants share their experiences with K–12 classrooms through interactive presentations. Sharing the experiences after the trip extends and deepens the understanding of the trip for the participants, as well as serving to educate others about study, research, and daily life in other countries. From blogs to online photo books, seminars, and poster presentations, there are many creative ways to disseminate information about the trip. Alert the university or institution's public information officer to encourage a media story about the trip.

FOR MORE INFORMATION

- National GK–12 website international profiles: http://www.gk12.org/international-profiles
- National Science Foundation. 2011. *Empowering the nation through discovery and innovation: NSF strategic plan for fiscal years* (FY) 2011–2016.
- National Science Foundation, Division of Graduate Education. 2007. Proceedings from the graduate teaching fellows in K–12 education (GK–12) project's workshop on international experiences in science, technology, engineering and mathematics (STEM). Washington D.C., August 27, 2007.
- Sigma-Xi. 2006. Embracing globalization: Meeting the challenges to U.S. scientists and engineers. Assuring a Globally Engaged Science and Engineering Workforce. Workshop report. National Science Foundation, September 20–22, 2006.

EXEMPLARS

INTERNATIONAL ENGINEERING ACADEMY IN THAILAND

University of Oklahoma, Norman

http://www.gk12.org/international-profiles/university-of-oklahoma-thailand/

A University of Oklahoma Fellow assists Thai science teachers in a water chemical test.

The University of Oklahoma GK–12 project implemented a seven-day International Engineering Academy (IEA) Teacher–student project in March 2009 and May 2011 at the Prince of Songkla University (PSU)—Wittayanusorn High School, Hat Yai, Thailand. Each year, IEA involved four GK–12 Fellows, two Oklahoma high school Teachers, and two principal investigators. In Thailand, IEA worked with approximately 40 Thai high school science and math teachers from seven national magnet high schools located across the nation. GK–12 Fellows introduced pedagogical concepts related to guided-inquiry learning and then engaged the teachers in one-day guided-inquiry lessons related to engineering. Lessons were developed by the GK–12 Fellows and were related to their graduate research. The lessons also incorporated data collection field trips, with PSU faculty involvement. Finally, Thai teachers taught the lessons to Thai high school students. Importantly, this was an exchange project: The Ministry of Science and Technology of Thailand provided financial support for four Thai teachers to travel to the University of Oklahoma to participate in its GK–12 Summer Engineering Academy.

CUTTING-EDGE RESEARCH IN ANTARCTICA

University of Colorado-Boulder Project EXTREMES

http://www.gk12.org/international-profiles/university-of-colorado-boulder-project-extremes/Antarctica

University of Colorado GK-12 Project Extremes team before boarding flight to Antarctica (top). Colorado Middle school science Teacher outside an emergency shelter near McMurdo Station, Antarctica (bottom).

Three GK–12 Project EXTREMES Fellows and one middle school science Teacher traveled to Antarctica for a month in 2009–2010 to participate in research related to the Fellows' doctoral dissertations in ecology and evolutionary biology. The GK–12 team collaborated with well-known researchers from the McMurdo Dry Valleys Long-term Ecological Research group in studies that involved stream ecology, soil chemistry, soil nutrients, and soil respiration. While in Antarctica, the team engaged K–12 students and teachers in this exciting research opportunity through a blog that captured young imaginations far beyond the Boulder Valley (http://cires.colorado.edu/blogs/extremes/). In addition, the team worked on the development of K–12 curriculum that focuses on the cutting-edge research taking place in Antarctica.

CREDIT: LOREN SACKETT (ANTARCTICA)

EXEMPLARS (CONTINUED)

EXPERIENTIAL LEARNING IN PERU

University of Alabama

http://bama.ua.edu/~gk-12

The University of Alabama (UA) GK–12 project developed a new relationship with a Peruvian University and aided in the development of an international experiential learning course. In addition, mutually beneficial research projects were adopted, incorporating both students who traveled to Peru and students who researched Amazonian infrastructure challenges from the UA campus. Examples of such projects are the installation of solar panels in rural Amazonian villages and the development of solutions to water and wastewater infrastructure problems. Some of the solutions proposed are under consideration for implementation by the local Loreto government in Peru. Participating Fellows integrated their international experiences into lessons for U.S. students, while a traveling U.S. Teacher published articles about it in the local paper. Several journal articles were published as well.

TRANSFORMING EXPERIENCES IN CHINA

University of Colorado–Denver

http://gk12.ucdenver.edu

The international component of the GK–12: Transforming Experiences project sent GK–12 Fellows and Teachers to China, where they observed Chinese middle school math and science classes, held discussions with Chinese teachers about lesson strategies, and spoke with middle school students. The project also examined the conceptual views of Chinese students with respect to science, the environment, and land. GK–12 Fellows traveling to China also worked on research projects with Chinese faculty and graduate students, including projects that addressed cycle structures, extremal graph theory, Ramsey theory, edge coloring, non-Hamiltonian bigraphs, and impartial combinatorial games.

Faculty and graduate students at Hunan University in Changsha welcome the GK-12 team from the University of Colorado Denver.

SOLAR COOKERS IN TANZANIA

Georgia Institute of Technology STEP GK-12

Georgia Institute of Technology STEP GK–12 Fellows traveled to Tanzania, where they implemented a solar cooker that they had designed. The cooker was designed to reduce the need to burn “dirty” fuels, such as wood or kerosene. The students worked with the village’s citizens in order to teach them how to use the cooker, as well as how to construct the simple structure with readily available materials. Project partners included the Science and Mathematics Magnet project at Georgia Institute of Technology, the United African Alliance Community Center in Arusha, Tanzania, several philanthropic groups, and the Westlake High School administration. Participants in project STEP reached out to local organizations and were successful in obtaining necessary funding for the trip.

A Westlake High School student member of Engineering Without Borders mixes concrete with his GK–12 Fellow mentor for use in a brick-making machine.

EXEMPLARS (CONTINUED)

COLLABORATIVE RESEARCH IN EGYPT

University of Houston

http://gk12.egr.uh.edu/

University of Houston GK-12 Fellow with international collaborators from the British University of Egypt following a science presentation.

The University of Houston's GK–12 project formed a collaboration with Professors Sami El-Borgi from École Polytechnique of Tunisia and Yehia Bahei El-Din from the British University of Egypt. GK–12 Fellow Nathan Howell traveled to Egypt for an entire summer to engage in international research related to environmental pollution by polychlorinated biphenyls (PCBs). The collaboration in Egypt allowed investigations to be conducted into theoretical sorption interactions of PCBs in the environment at a high-performance computing facility. This was not possible before, without the facilities provided by the host institution in Egypt. At the end of the summer, Howell and his host gave a presentation of their collaborative work to engineering faculty and students. He was deeply impacted by the experience from both a cultural and a scientific standpoint. A quote from Howell is illustrative: "I have had my first true collaboration experience, and I hope to have more. The synergy that happens, if the time is used well, is eye opening, and it makes me get excited about the research again, in a way that I have not been quite so much in a little while."

SPICE FELLOWS PLAN INTERNATIONAL EXPERIENCE IN SOUTH AFRICA

University of Florida

http://www.spice.centers.ufl.edu/

GK-12 Fellows and Teachers evaluate the health of a Nile Crocodile during their international research experience in St. Lucia Wetlands Park, South Africa. (The crocodile was not harmed in this research.)

GK–12 Fellows in the University of Florida's (UF) SPICE project organized a 2009 trip to South Africa. This international experience was unique because the Fellows were responsible for selecting the location, establishing contacts with in-country collaborators, and writing a supplementary proposal request to NSF to fund the trip. They were, however, guided through every step of the process by senior faculty members and by staff at UF's International Center.

The first step was to determine the trip's destination and purpose. SPICE Fellows chose South Africa, where UF had already established a strong partnership with researchers at the University of KwaZulu–Natal (UKZN); importantly, faculty and staff at UF's International Center had been instrumental in establishing that partnership and were eager to work with SPICE through another NSF graduate-training grant.

Fellows met weekly for most of a semester to plan the trip and craft the proposal. They interacted with an NSF program officer, who communicated clearly about how the proposal should be structured, and with several UF faculty members, who provided mentorship in all aspects of the project, but especially with how to locate and communicate with potential collaborators in South Africa and how to write the proposal. Three Fellows who contributed most to the planning became co-PIs on the proposal, an important professional accomplishment.

The primary goal of the trip was for Fellows to conduct research in collaboration with South African scientists so that both groups could learn new techniques and perspectives of science. A second goal was to learn about and contribute to the public education of South African adolescents in science. Because

EXEMPLARS (CONTINUED)

the theme of SPICE was ecosystem health, all Fellows were broadly interested in environmental issues and quickly organized themselves into three groups, each focused on developing a short-term research project on one of three themes: aquatic ecology, terrestrial ecology, and invasive species establishment. They contacted potential collaborators in South Africa with ongoing projects who would work with them for approximately three weeks.

Once funding was secured from NSF, planning became intense. All logistics associated with travel were handled by faculty and staff at UF's International Center. These people had been involved in the project from the outset, were strongly committed to it, and accompanied the Fellows in South Africa to provide support and senior leadership, so most of them were already familiar with the South African study sites, collaborators, and culture.

The trip lasted four weeks and included 14 Fellows. The first week included seminars at UKZN to introduce Fellows to the local educational system, the physical and cultural environments, and the scientific collaborators. Groups of Fellows associated with the three research themes finalized plans. Not surprisingly, the plans were often quite different than what had been anticipated six months earlier: Fellows learned about the importance of being adaptable and flexible when conducting international work. Some Fellows, for example, took advantage of unanticipated opportunities to pursue projects on their own or in subgroups.

One group worked on population genetics, habitat use, and impacts of environmental contaminants on Nile crocodiles in St. Lucia Greater Wetland park (iSimangaliso), the largest estuarine ecosystem in South Africa. Another group worked with the Natal Sharks Board to examine the ecology and physiology of sharks captured near public beaches. A third group studied the landscape ecology of ant communities. A fourth group completed experiments on diet selection in native birds, and the final group focused on the ecological impact of feral cats on native species. To date, this work has resulted in three manuscripts for publication, three dissertation chapters, four presentations at international conferences, four new grant proposals, and a position in the Peace Corps for one of the participants.

During the final week of the trip, four middle school Teachers who had been working with SPICE Fellows in Gainesville, Florida, joined the GK–12 team. They participated briefly in some of the research projects and shared in final presentations of the work to faculty, students, and other collaborators at UKZN. Then everybody visited several public schools, where they shared some of the hands-on, inquiry-based lessons they had developed together in Florida. All of the lessons related to ecosystem health and sustainability. The visit to one of the schools, Mandini, was especially eye opening. SPICE Fellows and Teachers were enthusiastically welcomed—which in South Africa includes boisterous song—and quickly inspired by the juxtaposition of positive attitudes and conditions far more impoverished than what most SPICE participants had previously experienced (or imagined). Soon thereafter, they established a sister-school project with a middle school in Gainesville that provides a high proportion of students with free or reduced meals (i.e., the closest possible counterpart to Mandini in Gainesville). Over the next year, large boxes of classroom supplies were collected from the Gainesville community and sent to Mandini, and a pen pal project flourished between adolescent students, who exchanged personal descriptions of life in two very different, yet very similar communities.

EXPLORING BIODIVERSITY IN FRENCH POLYNESIA

University of California (UC)–Berkeley

http://gk12calbio.berkeley.edu/

This international GK–12 effort was based on the island of Moorea, French Polynesia, where UC Berkeley has an active field station: the Gump South Pacific Research Station. The station has a cooperative agreement with the French Polynesian government "to document and protect the biological heritage of the islands." However, it is often difficult for scientists to communicate their knowledge to local communities, even more so when there are linguistic and cultural hurdles to overcome. One of the key conditions of linking the GK–12

EXEMPLARS (CONTINUED)

A UC Berkeley GK–12 Fellow describes characteristics of plants native to Moorea to fifth graders.

project with Moorea was that the GK-12 Fellows could maintain their research while involved in the project.

The project involved one or two GK-12 Fellows per year, in a manner similar to Exploring California Biodiversity, the primary GK–12 effort in California. Each Fellow spent an entire year in the school, working with Teachers and other educators in four classes at the primary partnering school, Ecole élémentaire de Paopao, in the Paopao community of Moorea, under the direction of Principal Mrs. Sylvie Juventin. A key element that made this partnership possible was that the island is sufficiently small to allow strong ties to be developed between U.S. graduate students and the schools. The educational system in French Polynesia follows the French model, with school mandatory between the ages of 5 and 16. Yet much of the population—especially the ethnic majority native Polynesians (78% of the population) —remains poorly educated.

The research focus was island biodiversity and ecology, divided into three units: (1) insect diversity; (2) plant diversity; and (3) marine biology. The primary goals were (1) to engage elementary school students in the process of science through studies of biodiversity and natural history collections and (2) to foster recognition and appreciation of science and the environment. Despite the island's having abundant biological resources (especially in the marine realm), local biodiversity is not often emphasized in the French Polynesian science curriculum, weakening students' appreciation for their natural environment. Indigenous Polynesian culture emphasizes the practicality of biodiversity, as a variety of plants and animals have been used for food, medicine, building materials, and tools for centuries. But the Western concept of science is not organic to the culture. As a result, scientific infrastructure is generally weak in the country, with little opportunity for students to pursue basic research. Those wanting to follow a career in science usually go abroad, often to France, once they reach university level.

For this effort, Fellows Brad Balukjian ('08 –'09) and Molly Wright ('09 –'10) were based at the Gump Station and taught weekly lessons in the local elementary school's fifth-grade class (CM2 in the French educational system). Additional graduate students were involved, but for shorter periods. A series of over 20 lessons was designed by the Fellows from scratch. Each lesson plan was evaluated to fit the local education standards and requirements. Both observation- and hypothesis-based science were covered, with emphasis on discovery, a notion that is critical for this age group. Fellows also served as conduits between research being conducted at the field station and the local K–12 community. The elementary school students were brought to the station to observe research in progress and also visited the Musée de Tahiti et des Îles, the natural history museum on the neighboring island of Tahiti. Toward the end of the year, GK-12 Fellows gave seminars to local teachers about how to create similar projects of international collaboration.

Key highlights included the following: (1) As the culminating event of the project during the first year, the "Exposition des Sciences," an elaborate science fair for the community, was hosted by students. This event was attended by such dignitaries as the French Polynesian Minister of Education, and it was covered by the local newspaper and TV station. (2) The GK–12 Fellows connected California urban schools with Moorea schools. Students wrote letters to each other and established an immensely satisfying cultural exchange, as the students realized how different (and similar) their lives and surroundings were in vastly different parts of the world.

Major outcomes included the following: (1) The project greatly enhanced global connectedness for the GK-12 Fellows, not only on-site in Moorea, but also in California. (Brad Balukjian and Molly Wright both participated in weekly meetings with California Fellows via Skype.) Balukjian and Wright are now fluent in French, have much improved teaching and communication skills, and have gained a deep appreciation of cultural differences; (2) The Fellows gained a better understanding of the local educational system and its

EXEMPLARS (CONTINUED)

differences with the U.S. system; (3) The Fellows strengthened their ability to communicate and work in a multicultural setting; (4) The Fellows improved their understanding of local history and culture, particularly through collaboration with the Te Pu Atitia Cultural Center; (5) The project influenced local perceptions. Indeed, the local community heralds this effort as one of the most important in outreach and education that has ever been attempted by U.S. researchers in French Polynesia! Having heard about the project from newspaper articles and the Teachers themselves, the government offices in Papeete now want to expand the effort to the main island. They are willing to provide whatever support is needed from the French Polynesian community.

Challenges included (1) establishing the confidence of the community; (2) navigating the labyrinthine bureaucracy of the French educational system; (3) adapting lesson plans for teachers to use on their own; and (4) linking to activities in Berkeley. Currently being explored are ways of building this effort to become a sustainable enterprise that links the research at the field station with the local schools.

EXTREMOPHILE RESEARCH AT THE UNIVERSITY OF NAIROBI AND IN KENYA'S GREAT RIFT VALLEY

University of Southern Maine

http://nanodiscoverylabs.org/index.php/maine.sciencecorps

University of Southern Maine GK–12 Fellows taking samples from Lake Magadi in Kenya.

Fellows in the Maine ScienceCorps project at the University of Southern Maine (USM) collaborated in international astrobiology research investigating microbes and bacteriophages of the extremely alkaline and hypersaline soda lake ecosystems of the Great Rift Valley. Research visits of GK–12 Fellows to Kenya began in 2008 and continued during 2009 and 2010 to establish the collaborative framework for long-term ongoing interactions between scientists at USM and the University of Nairobi (UoN). A total of five Fellows and one high school biotechnology Teacher traveled to Kenya.

Planning for this international research project began during 2007. The decision to apply for support for collaborative extremophile research in Kenya grew out of an existing collaboration between USM and NASA scientists and the knowledge that the soda lakes of East Africa include the most alkaline and hypersaline aquatic environments to be found anywhere on Earth. Through a NASA team already active in education and research in Kenya, the USM GK–12 project faculty and Fellows were connected with scientists at UoN in the Department of Geography and Environmental Studies. Of particular interest to the research team are the bacteriophages and viruses of the soda lakes. These organisms are the most abundant biological entities in most ecosystems, but are underexplored in extreme environments. It is expected that the interplay of these viruses and their hosts are critical in shaping nutrient cycles and driving microbial evolution in these unique halo-alkaline environments. Also among the soda lakes of Kenya are outstanding halo-alkaline hot-springs environments, such as the environment at Lake Bogoria, where thermophilic microbes and viruses can also be investigated.

After notification of the NSF award of supplemental international project funding, faculty research leaders at UoN and USM began to coordinate on obtaining the needed research permits and on scheduling an initial introductory meeting of the project leadership for January 2008 in Nairobi. This proved to be a challenging time to consider a new partnership, because the outcome of the national presidential election in Kenya during December 2007 was disputed and resulted in a time of unexpected violence and severe displacement of many people in some regions of the country. By April, advice from Kenyan colleagues

EXEMPLARS (CONTINUED)

indicated that traveling to Kenya for research would be safe. In May and June, the PI and research staff from USM visited to lay the groundwork for the collaborative research and to plan for Fellows to begin research participation later in the year. During three years, Fellows and colleagues witnessed some important national transitions that culminated in the August 2010 referendum in which the Kenyan people approved a new constitution.

Setting up the requisite microbiology and molecular biology laboratory resources for the project at UoN came with the challenges of finding many needed supplies from a variety of local sources, but the project has been greatly enabled and made successful through generous sharing of laboratory space by Dr. Jacques Kabaru in the School of Biological Sciences and through the UoN research leader Dr. Francis Mwaura's commitment to the project field research efforts and vast knowledge of the Great Rift Valley lakes and the surrounding communities.

Fieldwork at Kenya's soda lakes, along with laboratory work in Nairobi and Maine, has resulted in the team isolating numerous microbes and viruses from the lakes. The USM–UoN team visited secondary schools and informal education centers located near the extremophile sampling sites and enhanced the microscopy resources at those sites. Light microscopes are necessary to directly view microbial populations, including those of the soda lakes. During the fieldwork, participants have greatly increased their awareness of the connections between scientific research and education, on the one hand, and the environmental conservation and development efforts of many Kenyan people, on the other. Local Maasai people near Lake Magadi, as well as the villagers and government officials near Lake Bogoria, have shown great interest in assisting in the research efforts and increasing understanding of the unique natural resources at the Rift Valley soda lakes, where they are actively engaged in building ecotourism initiatives to promote conservation while sustaining their cultural heritage. By staying at locally owned eco-lodges that are part of local ecotourism and conservation education initiatives, the USM and UoN team of researchers has become increasingly well acquainted with grassroots development efforts to which the research studies may positively contribute during the anticipated sustained partnership.

The USM–UoN collaborative research has resulted in the complete sequencing and structural analysis of several soda lake bacteriophages that are being studied as self-assembling nanostructures with potential nanomedicine applications. Recently, the USM investigators were awarded a Grand Challenges Exploration Phase 1 grant from the Bill and Melinda Gates Foundation for a proposal to continue working with Kenyan colleagues in developing a versatile soda lake bacteriophage-based vaccine platform for a prototypic multistage malaria vaccine.

RESOURCES

NSF Office of International Science and Engineering	Supports international collaborations and provides opportunities for students to conduct research abroad	http://www.nsf.gov/div/index.jsp?div=OISE
Asia Nano Forum	Network for sharing information and promoting collaborations around nanotechnology	http://asia-anf.org
India Report	Dr. Sonia Ortega's GK–12 visit to India includes potential venues for partnerships	http://www.gk12.org/files/2010/04/Ortega_India_Report.pdf
Consortium for Affiliates for International Projects (CAIP)	Network of scientific and engineering societies' activities in international dimensions of their disciplines	http://www.aaas.org/projects/international/caip/
Community Research and Development Information Service (CORDIS) for Science, Research, and Development	Managed by publication office of European Union. The site contains information about the EU Seventh Framework	http://cordis.europa.eu/guidance/welcome_en.html
Cosmos Education	International nonprofit organization dedicated to improving science education in developing countries	http://www.cosmoseducation.org/
Institute on International Education	Provides education and training to a diverse range of participants, sponsors, and donors	http://www.iie.org/
Charles Darwin Foundation	Provides scientific research and technical information to support research in the Galápagos Islands	http://www.darwinfoundation.org/english/pages/index.php
The Fulbright Scholars Project	Offers U.S. faculty and professionals grants to teach and conduct research in many countries	http://www.cies.org/us_scholars/
International Long Term Ecological Research	Global network of research sites located in ecosystems around the world	http://ilternet.edu/
Organization for Tropical Studies	Consortium of 63 universities to support research in the tropics	http://ots.ac.cr
Peace Corps: Coverdell World Wise Schools	Resources related to schools involved with Peace Corp volunteers around the world	http://www.peacecorps.gov/wws/
German Academic Exchange Project (Deutscher Akademischer Austausch Dienst, DAAD)	Awards grants to conduct research and sponsors visits to Germany	https://www.daad.org
Smithsonian Tropical Research Institute (STRI)	Located in Panama, STRI provides opportunities for conducting ecological studies in the tropics	http://www.stri.si.edu/
Singapore International Graduate Award (SINGA)	Supports PhD training in Singapore	https://www.singa.a-star.edu.sg/
UNESCO	UNESCO sponsors projects and opportunities in K–12 education	http://www.unesco.org/new/en/education/
Earthwatch Institute	Supports teachers who seek to join expeditions around the world	http://www.earthwatch.org/aboutus/education
Global Exchange Resources	Promotes improvements in elementary and middle school mathematics instruction	http://www.globaledresources.com
Global Explorers	Nonprofit organization that organizes workshops for students and teachers	http://www.globalexplorers.org/projects/group_travel/
GLOBE	Promotes and supports students, teachers, and scientists who wish to collaborate on inquiry-based investigations about Earth's environment	http://classic.globe.gov/
International Education and Resources Network (iEARN)	Global network that enables teachers and students around the world to use the Internet to collaborate on projects	http://www.iearn.org/index.php?q=index.html
Japanese–U.S. Teacher Exchange Project for Education for Sustainable Development (ESD)	Supports U.S. teachers and administrations in traveling to Japan to learn about ESD and strengthen curricula in both countries	http://www.iie.org/en/Projects/ESD