GLOBE: A New Model in K–12 Science Education

Elena Bautista Sparrow, School of Agriculture and Land Resources Management, University of Alaska Fairbanks

What is GLOBE?
The Global Learning and Observations to Benefit the Environment (GLOBE) Program is an international, hands-on, inquiry-based environmental science and education partnership. It brings together students, educators, scientists, schools, communities and countries in environmental studies and cross-cultural enrichment. GLOBE stands out among many excellent environmental education programs because it provides unique educational and scientific benefits around the world. GLOBE provides the opportunity for all students in K–12 classrooms to engage in authentic hands-on Earth science research. Students essentially learn science by doing science.

The original concept for the GLOBE program was first introduced in former Vice President Gore’s book Earth in the Balance (1992): “Central to any strategy for changing the way people think about the Earth must be a concerted effort to convince them that the Global Environment is part of their ‘backyard’ … I propose a program including as many countries as possible that will use school teachers and their students to monitor the entire Earth.” The GLOBE Program was initiated in April 1994, in conjunction with the annual celebration of Earth Day (Finarelli, 1998).

Goals of the GLOBE Program:
- to improve students’ achievement in science, use computer and network technology, and help teachers meet local education standards,
- to expand the pipeline of potential future scientists and researchers for industry, academia and government,
- to increase student awareness of the global environment from a scientific viewpoint, without advocacy relative to issues, and
- to improve student understanding of science by involving them in performing real science—taking measurements, analyzing data, and participating in collaborative research with scientists.

In the United States, GLOBE is an interagency program of the National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Science Foundation, Environmental Protection Agency, and Departments of Education and State. Implementation in the United States depends upon the efforts of 140 partner organizations consisting of colleges, universities, state and local school systems and non-government organizations. GLOBE has been adopted by schools in every state. Worldwide partnerships were established through bilateral agreements between the United States and its international partners, which are then responsible for designing program implementation in their own countries. To date, more than a million K–12 students in more than 10,000 schools and 16,000 teachers in over 95 countries are participating in this program.

In Alaska, the GLOBE program was established in November 1996 through a cooperative agreement between GLOBE and the University of Alaska Fairbanks (UAF) through the Center for Global Change and Arctic System Research. Elena Sparrow, coordinator of the Alaska Global Change Education Program, has been the UAF Alaska GLOBE program coordinator since its inception. The UAF-GLOBE Partnership has trained 100 teachers in 73 schools, four school administrators, three education specialists, four environmental educators, and five environmental specialists from Alaska Tribal Councils, in the GLOBE program.

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GLOBE protocols

Scientists and educators comprise the GLOBE science/Education Teams for each discipline area: Atmosphere/Climate, Hydrology, Soil, Land Cover/Biology and Plant Phenology. The teams developed age and skill level-appropriate and scientifically valid protocols for standardized measurements and support materials. GLOBE protocols were chosen based on the following criteria:

- the data have research significance
- the procedures can be done by primary and secondary school students
- the equipment need is inexpensive enough for schools to purchase

Professional development workshops enable GLOBE teachers to guide their students in taking scientific measurements at or near their schools, in using the Internet to report and analyze scientific data, and in collaborating with scientists and GLOBE students worldwide.

Benefits for Students

"GLOBE is the quintessentially ideal program for involving kids in science." —Nobel laureate Dr. Leon Lederman (GLOBEoffline, 2001). GLOBE students gain first-hand science knowledge and experience through their observations, accurate data collection and use of the data in their investigations, instead of just reading about it. An Alaska Native student from Innoko River School in Shageluk, said “The thing I liked best about GLOBE was that we had to use our hands on such things as measuring trees and oxygen testing of the water. This is the best science class I ever took in my life.” Another Alaskan student said that she would recommend GLOBE to other students and that it made her look at the environment differently.

GLOBE is good for all students, including those who may be uninterested in science or shy away from science. According to Kathleen Meckel, a Fairbanks teacher, the GLOBE phenomenology activities were especially good for Native students who tend to be quiet learners and not as articulate in class discussions. She found the students to be competent in taking the GLOBE measurements and they enjoyed doing it. According to another Alaska teacher, Cerie Stihler, GLOBE does more than benefit the environment. It also benefits eager young minds. “Never in all my years of teaching have I seen such excitement. Students who have never taken an interest in or enjoyed science and math now eagerly await our GLOBE work."

In addition to specific protocols, GLOBE students of all ages learn:

- to work together in teams
- to see a relationship between their work and the work of scientists and other students
- to see the relationship of their observations and long-term patterns taking place at their study sites, their neighborhoods, their regions and the world
- to answer questions based on their measurements and observations, rather than simply from textbooks
- to sometimes question those answers
- to appreciate that some questions do not yet have answers
- to use methodologies, analyses and other skills required by many state education standards
- to realize that science is a process and not the answer.

A 1996-97 evaluation by SRI International, a California firm with world-renowned expertise in education evaluation, found that GLOBE is characterized by strong teacher and student enthusiasm, strong adaptability to a wide range of grade levels and contexts, and compatibility with collaborative and inquiry learning models. Students in active GLOBE classrooms have a very positive view of the importance of their GLOBE activities: 83 percent think GLOBE will help people better understand the Earth and 78 percent believe that the data they are collecting are important to scientists.

From GLOBE Year 2 evaluation (Means, 1997), GLOBE teachers’ perceptions of the biggest impact of GLOBE on student learning are in the following areas: observations skills (69%), measurement skills (68%), technology skills (60%), understand data (50%), work in small groups (50%), critical thinking (36%), and map skills (30%). GLOBE students performed better than their peers in non-GLOBE classes on assessments of their knowledge of measurement procedures, sampling and measurement principles, interpreting data and applying concepts, and interest in pursing a career in science (Means, 1997).

Another major benefit in GLOBE is the opportunity for students to reach out beyond their countries, learn about geographic conditions (besides gaining hands-on experience to develop geographic skills such as understanding scale, latitude, longitude, map elements and spatial analysis), natural resources and cultural characteristics of other regions in the world.

Benefits for Teachers

According to Dr. Diola Bagayoko, GLOBE partnership coordinator at the Southern University and A & M College in Baton Rouge, Louisiana, GLOBE provides a comprehensive, coherent, flexible tool for the actual implementation of the
prevailing science and mathematics reform blueprints, including the Benchmarks of Science Literacy, some NCTM Standards, and the National Science Education Standards (GLOBEoffline, 2001). In North Carolina the state education department’s newly revised standards embraced the GLOBE program since GLOBE best fits the competency goals in middle school (GLOBEoffline, 2000). The University of Montana at Missoula has incorporated GLOBE training into the curriculum for pre-service elementary and high school teachers, while the Georgia Institute of Technology is using GLOBE to help teachers find meaningful educational classroom applications for computers and the Internet.

Because GLOBE has an integrated approach, teachers use GLOBE activities to promote skill development and to meet standards in not only math and science but also reading, writing, computer literacy, language arts, foreign language, geography and “life-long learning” skills. Nancy Johnson in Palmer, Alaska uses GLOBE activities in lessons and units in language arts for middle school students, while in Idaho elementary students correspond in Spanish with GLOBE students in Argentina.

Benefits for teachers include university credit (when they are GLOBE trained) for continued teacher accreditation or for use in a graduate degree they are pursuing. Teachers also receive educational materials (such as the GLOBE Teacher Guide, cloud chart, tree guide, videos on remote sensing, and GLOBE protocols on Hydrology, Soils, and Land Cover/Biology). Teachers have continued support through the GLOBE web site (http://www.globe.gov), managed by teams of technology experts to keep the site on the cutting edge while being user friendly, teacher list-serve, emails, phone calls and GLOBE web chats and the GLOBE Help Desk.

There are other opportunities for professional development through additional workshops/conferences and for collaboration with scientists and with other GLOBE teachers locally, statewide, nationally and worldwide. Additionally, teachers are given the opportunity to make a difference in the lives of their students through an integrated science education approach, and contribute to knowledge about the earth and earth systems. Stipends and GLOBE instrument kits may also be available to GLOBE teachers depending on availability of funding for GLOBE-related projects.

Benefits for Scientists
GLOBE, which tightly couples a science research program and a science education program, has addressed the issue of student data quality for scientific investigations (Budd et al., 1996; Rock and Lawless, 1997; Becker et al., 1998; Mims, 1999). Carefully designed scientific measurements, if properly followed, ensure accurate data. Accuracy and consistency are prerequisites for scientific use of data and persistence and coverage also contribute to the scientific value of data (GLOBE, 1999). GLOBE also employs electronic screening of data to limit sources of error. Valid student-collected data benefits not only the students, who gain first-hand science knowledge and experience, but also the scientists, who gain a large database (Congalton and Becker, 1997) at reduced cost and time involved in collecting the needed large quantities of data.

Meteorologists working on a haze-monitoring program found that data collected using LED-based Sun photometers by GLOBE students at a high school near NASA’s Goddard Space Flight Center (GSFC) compared favorably against aerosol optical thickness measurements from Sun photometers used at GSFC, demonstrating that students can reliably make the required measurements (Brooks and Mims, 2000). Becker et al. (1998) found that land cover reference data collected by students using GLOBE protocols are at least as accurate as those collected by professionals. “The comprehensive suite of GLOBE measurements that is being collected by students is critical for Earth science research—for assessing current conditions, for monitoring changes and for driving, testing, and creating models for predictions into the future” according to Dr. Elissa Levine, a soil scientist at NASA’s Goddard Space Flight Center in Maryland (CERPS, 1999). GLOBE student daily surface-based cloud cover observations are potentially the only reliable comprehensive sky observations available to scientists who study clouds and their effects, according to Dr. Paul Ruscher of Florida State University.

The gathering of accurate ground validation/reference data is fundamental to use of remotely sensed data for land cover classification and mapping (Congalton and Becker, 1997; Fried et al., 1996) and for observations across large areas, of important plant stages and changes in the plant growing season length which may be used as signals of short- and long-term climate variability and help determine appropriate greenness values for different regions (Verbyla et al., 1999; White et al., 2000).

Through the efforts of GLOBE students, an accurate determination of the location and extent of forests, wetlands, grasslands, farmland, roads, buildings and other natural and human-made land use is being accomplished, enabling students and scientists to track how land uses change with time (GLOBEoffline, 2001).

Benefits for Others
The GLOBE learning community has grown to include not only young students but also retirees (GLOBE Offline, 2001). For example, as any GLOBE student, Florence Martin learned to read and record measurements from her study site instrument shelter. Yet unlike most students she turned 90 on the day that Mobile, AL measured a record high of 105°F last summer. She and other seniors say that they have enjoyed the
opportunity to master GLOBE scientific protocols, to satisfy their curiosity about the environment and to make a contribution. Anne Marshall, a certified therapeutic recreation specialist, found that GLOBE senior participants showed a measurable improvement in psychological well-being compared to a control group. The GLOBE program helps to achieve the goal of meaningful activity in that the work is useful to others. GLOBE director Tom Pyke says, “GLOBE is not only about lifelong learning but also about lifelong contributions to knowledge of the world.”

References
GLOBE Offline, the GLOBE program’s newsletter. Spring 1998, Spring 1999, Volume III 2000 No. 1; Volume IV 2000 No. 2; Volume V 2001 No. 1; The GLOBE Program, Washington D.C.

2001 Student Research Grant Recipients

The following students are recipients of this year’s Student Research Grant Awards from the Center for Global Change and Arctic System Research. For the second year in a row, two of the awards (Hector Douglas and Dmitriy Dukhovskoy) are being funded through a partnership with the Alaska Sea Grant College Program. We are grateful for their continued support!

William R. Bolton, Institute of Northern Engineering
Dynamic modeling of the soil moisture and hydrologic processes in areas of discontinuous permafrost

Hector Douglas, Institute of Marine Science
Planktivorous anchovies as biomonitors of environmental change in marine food webs

Dmitriy Dukhovskoy, Institute of Marine Science
Study of the decadal variability of the freshwater flux in the arctic basin - North Atlantic system

Daniel Elsberg, Geophysical Institute
Glacier equilibrium line and terminus measurements with an integrated airborne video and laser altimetry system

Jill Johnstone, Institute of Arctic Biology
Interactions between fire, climate, and vegetation succession in boreal forest

Chris Larsen, Geophysical Institute
Coastal glaciers and sea level change: a case study in the Glacier Bay uplift region, southeast Alaska

Jack McFarland, Department of Biology & Wildlife
The role of organic N in the nitrogen economies of terrestrial forest ecosystems: a cross-site approach

Michael Palmer, Institute of Marine Science
Groundfish growth response to climate variability in the Bering Sea

Christin Pruett, University of Alaska Museum
Global change and song sparrow populations in Alaska: an assessment of temporal and spatial changes using molecular markers

Tina Tin, Geophysical Institute
Using shipboard observations to monitor sea ice thickness distribution in seasonal ice zone

Katy Walter, Institute of Arctic Biology
Controls on methane flux from thermokarst in Northeast Siberia

Martin Wilkening, Forest Sciences
Climate change in the treeline ecotone in interior Alaska’s national parks: are the trees really better off?