GLOBE YEAR 1 EVALUATION

Findings

October 1996

Prepared for:

Global Learning and Observations to Benefit the Environment (GLOBE)
744 Jackson Place
Washington, D.C. 20503

The Year 1 evaluation of the GLOBE Program was conducted by the Center for Technology in Learning of SRI International under Grant # ESI-9509718 with the National Science Foundation.

SRI International

™

October 1996

GLOBE YEAR 1 EVALUATION

Findings

Prepared for:

Global Learning and Observations to Benefit the Environment (GLOBE)
744 Jackson Place
Washington, D.C. 20503

Prepared by:

Barbara Means
Teresa Middleton
Amy Lewis
Edys Quellmalz
Kathryn Valdes

SRI Project 6992

The Year 1 evaluation of the GLOBE Program was conducted by the Center for Technology in Learning of SRI International under Grant # ESI-9509718 with the National Science Foundation.

SRI International ◆ 333 Ravenswood Avenue ◆ Menlo Park, CA 94025-3493 ◆ (415) 362-6200

Executive Summary

Global Learning and Observations to Benefit the Environment (GLOBE) is an international environmental science and education program involving elementary and secondary school students in the collection of data concerning their local environments and the sharing of that data through the Internet. GLOBE seeks to strike a balance between its scientific objectives—to obtain accurate and reliable data to enhance our scientific understanding of earth systems—and its educational goals—to promote science and mathematics learning and environmental awareness. Although the involvement of students in the collection of environmental data, interchanges with practicing scientists, international telecommunication, and the sharing of data through the Internet have been features of previous education programs, GLOBE is unique in terms of the scale of its initial implementation (more than 1,500 schools in its first year) and in the weight it gives to science, with students involved in real ongoing research investigations by earth scientists.

GLOBE differs from a number of science education programs also in the flexibility it offers to schools and teachers. Other than requiring careful adherence to the data collection protocols, GLOBE gives schools complete latitude in determining the (K-12) grade levels and classes in which to implement the program, the educational activities to provide, and the way in which the program will fit into the local curriculum.

GLOBE teacher training sessions began in March 1995; by year end, 1,659 U.S. teachers had received 3 to 4 days of GLOBE training. International workshops for GLOBE country coordinators outside the United States were held in three locations around the world during the summer of 1995. The country coordinators then set up and conducted their own teacher training programs. By April 1996, 173 international (non-U.S.) schools from 19 countries had contributed to the GLOBE data archives.

The Evaluation

SRI International was selected through a competitive grant process to provide GLOBE's evaluation component. To obtain information on how GLOBE is being implemented, on the challenges involved in implementation, and on the perceived effects on students, SRI developed teacher surveys, which were administered during April and May of 1996. A random sample of 400 teachers from among those trained in the United States in 1995 were asked to complete the survey, and 310 did so. In addition, those teachers whose schools were active providers of GLOBE data between January and March 1996 (250 U.S. schools and 30 abroad) were asked to complete surveys. Among these active data providers, 229 U.S. and 28 international teachers returned surveys. The surveys for U.S. GLOBE teachers were made available in both hard copy form and on the World Wide Web. Among U.S. GLOBE teachers responding to the survey, 44% used the World Wide Web version and 56% submitted print surveys.

In addition, teachers in the U.S. schools that were actively providing data and whose most active GLOBE class contained fourth, seventh, or tenth graders were asked to administer a survey to their students. Separate versions of the survey were prepared for elementary and middle/secondary students. Surveys were received from 1,122 students, comprising 771 fourth graders, 237 seventh graders, and 114 tenth graders, from 73 GLOBE schools. Embedded within the student surveys were items assessing concepts and skills related to GLOBE activities.

The evaluation team also conducted site visits to five U.S. sites representing a range of geographic areas and grade levels. These visits, conducted between March and May 1996, incorporated interviews with GLOBE teachers, observations of GLOBE activities, informal discussions with students, and interviews with administrators.

The Findings

We estimate that more than 85,000 students in the United States participated in GLOBE during its first full year of implementation. Among U.S. teachers implementing GLOBE with students, 97% reported that during a typical week they have students take GLOBE measurements. Seventy-six percent reported that their students enter GLOBE data on a computer; 45% have students compare different sets of GLOBE data; 39% use the visualizations; 36% write about a GLOBE activity or data set; 29% telecommunicate with other GLOBE schools; and 11% talk or interact with a scientist.

Roughly 30% of those U.S. teachers trained by GLOBE reported on the survey that they had not yet implemented the program with students. Among these teachers, the largest single perceived barrier was absence of the network and computer infrastructure needed to fully implement GLOBE. The second major category of barrier concerned time: first, the time needed to plan and set up for the program and then the blocks of time needed in the school schedule. Among these nonimplementers, 95% reported that they did expect to implement GLOBE in the future. Assistance these teachers say would help them get the program started includes, first, help obtaining full Internet connectivity and, second, local training sessions in which they could interact with other GLOBE teachers.

Among teachers who have implemented the program with students, the biggest perceived challenge is obtaining measurements during weekends and vacations. A variety of time pressures constitute the next most difficult issues: completing GLOBE activities within the confines of the school schedule of brief blocks of instruction; finding a place for GLOBE, given other curricular and testing demands; and finding enough of their own time to conduct the preparation and support work needed for implementing GLOBE. When asked to rate the value they would derive out of a number of potential enhancements to GLOBE, teachers gave the highest priority to student investigation and analysis ideas, integrating themes that cut across investigation areas, and modularized teacher guidebooks. Among teachers who wrote in ideas for additional supports, the most common type of suggestion was for additional teacher training or mentoring.

The biggest perceived impacts on student learning are in the areas of observational skills (72% of U.S. teachers actively providing data reported that GLOBE had improved skills "very much"), measurement skills (70% "very much"), and technology skills (68%). Roughly half of these teachers thought GLOBE had very much improved students' abilities to understand data and to work in small groups. Smaller but still significant proportions reported major improvements in critical thinking (38%) and map skills (35%). Among the various investigation areas, the largest increase in student knowledge, in teachers' view, is in the area of atmosphere and climate, with 85% of U.S. teachers actively providing data reporting that their students' knowledge had increased "very much."

The students themselves ranked putting GLOBE data on the computer as the most popular of the activities included on the survey (with 74% saying they like doing this "a lot"). Nearly as popular were looking at satellite measurements (68%) and taking measurements (64%). Students reported that GLOBE differs from other school activities in that they experience less boredom, less answering of questions from a book or worksheet, and less confusion about what they are supposed to be doing.

Students in active GLOBE classes have a very positive view of the importance of their GLOBE activities: 86% say that they think the GLOBE project will help people better understand the earth and 84% that their measurements are important for scientists. Only 15% say that they do not know why they take the measurements they do. GLOBE students also show appreciation for the fact that mathematics is frequently required when doing science (88% agree).

The pilot version of the embedded student assessments suggests that students in active GLOBE classes have the knowledge needed to take accurate GLOBE measurements in the areas of air temperature, precipitation, and canopy cover (with an average of 73% correct responses). Classification of clouds appears to pose problems for many students (average of 38% correct). Performance on assessment of concepts of data quality and sound measurement procedures was in the middle range (average of 42%). Ability to apply science concepts related to GLOBE investigation areas varied widely across different topics, but averaged 56%, with the poorest performance on items related to soil moisture (21%).

Emerging Issues

The first-year evaluation highlighted some issues for GLOBE to consider as it continues to evolve and refine its support structure.

- *First, the program requires a significant investment of teacher time, motivation, and persistence*. Continued scale-up will require making procedures and technology more "goof proof" and easier to use. Many teachers will not be willing or able to put in the kind of time, creativity, and energy invested by the early adopters.

- *A related concern is the need for more mechanisms for ongoing teacher support*. When a single teacher is trained from a school, there is often a sense of isolation from the program after leaving the training workshop. This situation can be ameliorated in part by the new policy of training more than one teacher from a given school. Even so, teachers want and need both network and face-to-face communication with other GLOBE teachers and with scientists. Provision of refresher training sessions, mentor teachers, and additional training content through the Web page and listservs can help address these needs and also contribute to data quality through better control over the data collection procedures taught to students.

- *Some portions of the program, notably the soil moisture investigations and the visualization software, are getting only limited implementation*. In large part, this omission appears to be a function of difficulty combined with limited training. The new edition of the Teacher's Guide will help tie both of these areas in with other GLOBE activities and offers easier-to-execute instructions for soil moisture.

- *Another major area of concern is the need to ensure that data collection does not get divorced from conceptual learning*. Schools tend to judge their success with GLOBE solely on the basis of the amount of data they have contributed to the archive. Moreover, when students collect data, not all of them have a conceptual framework for understanding the significance of the information they are obtaining or of the data visualizations on the GLOBE home page. More attention to GLOBE's learning objectives and the provision of additional learning activities are important steps toward addressing this issue.

- *A related concern is teachers' need for guidance in keeping an entire class involved with GLOBE*. GLOBE measurements are most easily taken by small groups of students. In some schools, the same few students collect and report the data every time. The stress on learning objectives and suggested educational activities cited above can help address this problem also. In addition, teachers would like to see model classroom management strategies for involving entire classes with GLOBE.

- *Finally, many GLOBE teachers are grappling with the challenge of trying to spread the program beyond their own classrooms to encompass a much wider portion of their schools*. At present, GLOBE teachers receive little training and, in most cases, few resources for school-level implementation activities. Some districts, however, are sponsoring wider GLOBE training, and such activities should be encouraged. We recommend training multiple teachers and the principal from a school together in order to increase administrator buy-in, spread the program more widely through the school, and reduce the burden on a single individual.

Conclusion

The GLOBE program has made impressive progress in its first year, developing a set of measurement protocols, assembling an initial set of learning activities, establishing an extensive support infrastructure, and implementing a broad-scale teacher training program. Although not all portions of the program have been implemented fully in GLOBE schools, enthusiasm and support for the program remain high among those teachers who have implemented some part of it. Just as important, the program is giving students a new perspective on what it means to do science and to be part of a scientific investigation. GLOBE's combination of hands-on activity, use of technology, and involvement in real research projects not only has wide appeal for students but also provides them with a deep sense of the value of their activities. In its second year, the program will expand its range of investigations and refine Phase I protocols to reduce opportunities for the introduction of error. By also addressing the challenges discussed above, the program can demonstrate the compatibility of good science and good education.

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

TABLES

FIGURES

EXHIBITS

Chapter 1. Introduction

Global Learning and Observations to Benefit the Environment (GLOBE) is an international environmental science and education program involving elementary and secondary school students in the collection of data concerning their local environments and the sharing of that data through the Internet. GLOBE seeks to promote students' learning of science by involving them in real scientific investigations, involving detailed data collection protocols for measuring the characteristics of their local atmosphere, soil, and vegetation. Students then use data entry forms on the World Wide Web to submit data to a central archive, where it is combined with data from other schools to develop visualizations that can be viewed on the Web. Use of a Global Positioning System (GPS) locates each GLOBE data site precisely and permits students to relate what they see around them to satellite images of their area provided by GLOBE.

Although the involvement of students in the collection of environmental data, interchanges with practicing scientists, international telecommunication, and the sharing of data through the Internet have been features of previous education programs such as Kids Network and Global Lab, GLOBE is unique in terms of the scale of its initial implementation (more than 1,500 schools in its first year) and in the weight it gives to science, with students involved in real ongoing research investigations by earth scientists. GLOBE seeks to strike a balance between its scientific objectives—to obtain accurate and reliable data to enhance our scientific understanding of earth systems—and its educational goals—to promote science and mathematics learning and environmental awareness.

GLOBE differs from a number of science education programs also in the flexibility it offers to schools and teachers. Other than requiring careful adherence to the data collection protocols, GLOBE gives schools complete latitude in determining the (K-12) grade levels and classes in which to implement the program, the educational activities to provide, and the way in which the program will fit into the local curriculum.

A Brief History

On Earth Day (April 22) 1994, Vice President Al Gore enunciated the concept for the GLOBE program and invited the participation of countries from around the world. An interagency team, including the National Oceanic and Atmospheric Administration

(NOAA), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Departments of Education and State, was set up to turn the Vice President's vision into a reality.

A workshop of scientists and educators was held in Aspen, Colorado, in September 1994 to identify the minimum set of areas in which students would need to make measurements in order to advance both their own understanding of the earth as a dynamic system and the scientific database about our globe. The three broad areas for scientific measurement that emerged from the workshop were (1) atmosphere/climate, (2) hydrology/water chemistry, and (3) biology/geology. Scientists worked with the GLOBE program staff to develop data collection protocols for each investigation and to identify reasonably low-cost equipment that students could use to make the measurements with an acceptable degree of accuracy and reliability. Materials from existing environmental education programs were combed to identify educational activities related to the measurement protocols.

A Federal Register notice published November 23, 1994, invited U.S. schools to apply to become GLOBE participants. Requirements for participation, which included an Internet connection and a computer capable of running a Web browser and data visualization software, were described. Schools interested in participating in GLOBE that lacked the needed equipment or Internet connection were invited to apply for federal assistance if they could demonstrate financial need. (Subsequent announcements did not include the option for federal subsidy.) Schools applying to join GLOBE had to commit to the schedule of data collection (which included weekends and school vacations) and to participation for a 3-year period.

By March 1995, the 400-page First Edition of the Teacher's Guide was ready and GLOBE began training teachers. The official launch for the Phase I program was held on Earth Day 1995.

Teacher Training

For Phase I, the GLOBE training model for the United States was one of GLOBE-arranged training for one teacher from each GLOBE school. Training sessions were hosted by space grant programs at roughly a dozen university sites across the country. Training was conducted by teams composed of a facilitator plus two scientists, two technology specialists, and two educators (by the summer of 1995, GLOBE teachers trained earlier were able to fill this role). Often someone from the host university filled one of the scientist roles. Training sessions were planned for 3 days, with an optional fourth practice and refresher day, and included discussion and conduct of each of the data collection protocols, a limited number of educational activities, and practice with the Internet and with using MultiSpec software for manipulating satellite images. Given the wealth of material to be covered, evening as well as daytime training activities were conducted. Training sessions began in March 1995 and continued throughout the year. In total, 1,659 teachers received GLOBE training during 1995.

International Participation

From the first, Vice President Gore envisioned GLOBE as an international program "involving as many countries as possible that will use school teachers and their students to monitor the entire earth" (Gore, 1992). The Vice President sent letters to heads of government in countries around the world inviting them to join the GLOBE Program. In November 1994, a meeting between GLOBE educators and educators from GLOBE partner countries around the world was held in Washington, DC. The purpose of this meeting was to discuss the development of the educational materials to be used in conjunction with the GLOBE science protocols, to solicit input and comments on the materials, and to review environmental education materials used in partner countries for their possible inclusion in the GLOBE materials. By June 1995, 113 of 183 invited countries had expressed an interest in joining GLOBE.

Internationally, GLOBE runs as a cooperative science and education program. Bilateral agreements specify the respective roles and responsibilities of the United States and its international partners. Cooperation is conducted on a no-exchange-of-funds basis. GLOBE provides the program infrastructure; the international partners manage their own implementation, acquiring the resources necessary to equip their own schools. Each country has substantial flexibility in how it manages its GLOBE activities. It selects its own Country Coordinator, decides how many and what schools to sponsor, and determines how GLOBE will be implemented in its schools. The only requirement is that participating schools conduct the measurements in accordance with the GLOBE data collection protocols, using equipment that meets GLOBE specifications, under the supervision of teachers trained by GLOBE-trained teachers.

International workshops for country coordinators were held in four locations around the world during the summer and fall of 1995. The country coordinators then set up and conducted their own teacher training programs. Approximately 230 international teachers received GLOBE training in 1995. Some of the materials on measurement procedures and data reporting were translated into the six United Nations languages; many countries, however, were interested in using GLOBE as a way to promote their students' learning of English. Some international partners are developing their own Web sites (e.g., Greece, Japan, the Netherlands, Germany, and the Czech Republic).

Phase II

While the GLOBE program was gearing up for its Phase I teacher training and Earth Day launch, it was also laying the groundwork for a second phase to involve a larger collection of scientific investigations, original educational activities, and curriculum integration and evaluation activities. In November 1994, the National Science Foundation issued an announcement inviting applications from teams of earth scientists and educators interested in shaping the GLOBE Phase II investigations. Teams were sought to design scientific investigations in the areas of atmosphere/climate, trace gases, water chemistry (e.g., water temperature, pH, and oxygen content), hydrology (e.g., water cycle), and land cover, and in the use of global positioning systems (GPS). Grants for integration activities and a program evaluation were also competed through the same announcement. Work on the Phase II materials began in May 1995 and continued through July of the next year, when the first draft of the Second Edition of the Teacher's Guide became available for training teachers in the summer of 1996. Next year's evaluation report, on the 1996-97 school year, will provide a look at the Phase II protocols and educational activities.

Overview of This Report

This report emphasizes the educational aspects of GLOBE, describing as well as assessing the effort during the first full school year (1995-96) of GLOBE's implementation. In the next chapter, we provide a brief overview of the data sources and methods used to provide the information for our analysis. Chapter 3 describes the first year's experience with teacher training and student data collection, based on databases developed and maintained by the GLOBE program. Chapter 4 relies on information provided in teacher and student surveys conducted by SRI International to profile the teachers and students involved in GLOBE. Chapter 5 describes the implementation challenges and strategies for meeting them, based both on our surveys and on phone interviews and on-site observations and interviews. A preliminary look at the program's impact on students and teachers is provided in Chapter 6. Recommendations for program enhancements based on these findings are presented and discussed in Chapter 7.

Chapter 2. Overview of Evaluation Methodology

In this chapter, we provide an overview of the data sources and methodology applied in our evaluation of the first year of GLOBE activities.

In evaluating the GLOBE program's first full school year of operation, our major focus lay in discerning the extent to which the program is being implemented as intended. Subsequent evaluation reports, using data from the program's second and third years, will give more emphasis to assessing the outcomes of the program, i.e., its success in meeting its goals for student learning, environmental awareness, and scientific data. The four main sources of information available to us in Year 1—databases developed by GLOBE and our own teacher surveys, student surveys, and case studies—are described below.

GLOBE Databases

Master Database. NOAA has maintained a master database of "registered" U.S. GLOBE schools since the project's inception. The initial database information comes from the school's GLOBE application. Data fields are added as the GLOBE teacher completes training, qualifying the school to submit data to the GLOBE data archives.[1] The master database includes the school's name and address, name and contact information for the GLOBE-trained teacher and the principal, the school level, and the date and location of the GLOBE teacher's training. The schools in this database whose teachers had completed training by the end of 1995 provided the "universe" from which we selected our Trained Teacher survey sample, as described below. In addition, we used this database to determine the numbers of teachers trained each quarter during 1995 (as described in the next chapter).

Student Data Archive. NOAA also maintains the central GLOBE database to which students submit their measurements. The data archive contains the name and location information for the school submitting the data, the type of data, date on which the data were collected, and the specific readings. NOAA uses this database to generate a Web page of "GLOBE Stars" listing schools that have submitted various amounts of data (e.g., 500 data elements or more submitted). This database was used in the evaluation as a source for identifying highly active GLOBE schools for the case studies and for the

[1] International schools are entered into the database after the Country Coordinator informs the GLOBE Office that a teacher has been trained and provides school contact information and the school's latitude, longitude, and elevation.

survey of Active Data Providers (as described below). We also calculated the number of U.S. and international schools reporting data during the 1995-96 school year, the frequencies with which the various data categories were reported, and the frequency distribution of school data reports, all presented in the next chapter.

Help Desk Queries. GLOBE maintains a Help Desk facility at NASA-Ames in Sunnyvale, California. An 800-number hotline for the Help Desk was made available to teachers at their training and is listed on the GLOBE home page. NASA maintains a database of requests received, showing the medium through which they came in (i.e., hotline call, electronic mail, or Web query), as well as the nature and month (later quarter) of the query. These data are summarized in the next chapter.

Teacher Surveys

Information on just how GLOBE is being implemented, the challenges involved in implementation, and the perceived effects on students was derived from teacher surveys conducted during April and May 1996. A slightly modified version of the survey was developed for teachers in international partner countries. The full text of the teacher surveys is available in the Data Appendix. The surveys for U.S. GLOBE teachers were made available in both hard copy form and on the World Wide Web.

The range of issues to be addressed in the evaluation required the development of three teacher survey samples. First, we drew a simple random sample of 400 from the population of all teachers trained by GLOBE during 1995. Survey data from this sample permitted us to estimate the proportion of trained teachers who have not implemented the program with students (some teachers conducted GLOBE measurements with students but did not know how to enter them into the GLOBE database) and the nature of the population of GLOBE schools and GLOBE students. Throughout this report, we refer to these teachers as the Trained Teacher sample.

Realizing that many teachers might have only a partial implementation of GLOBE during the first year, we wanted also to survey those teachers who were most active in implementing the program. From their experiences, we can obtain a fuller picture of how the program works when it is really operational. A review of the Student Data Archive showed us that many schools batch their GLOBE data rather than submitting it on a daily or weekly basis. At the end of March 1996, we identified those schools with GLOBE teachers trained in 1995 that had submitted data on at least two occasions each in February and March and at least once in January (for part of which many schools were out of session), and whose data included at least three different data categories (i.e., the most frequently reported categories of temperature and rain would not suffice by themselves). Among U.S. schools, 250 met this criterion. The GLOBE teachers at all of these schools were asked to complete a survey (thus, technically speaking, this group comprises a census rather than a sample). Throughout this report, teachers from these schools are referred to as Active Data Providers. Our third sample was taken from international GLOBE partners. Among international partner schools, 30 met the same data reporting criterion used to identify U.S. Active Data Providers, and their country coordinators were asked to administer the International Teacher Survey to them.

It should be noted that 69 teachers in the randomly drawn Trained Teacher sample also qualified as Active Data Providers. They were asked to complete only one survey, but their responses are included in both data sets.

A letter announcing the upcoming survey and explaining its purpose went out to all teacher samples the first week of April. SRI mailed printed copies of the surveys on April 15. The cover letter and first page of the survey urged teachers who had World Wide Web access to complete the survey on the Web (the URL was provided). On May 1, nonrespondents were sent reminder postcards. On May 7, a letter from Tom Pyke, the GLOBE Director, urged remaining nonrespondents to send in their data. Another round of reminder postcards were mailed to nonrespondents on May 17. Electronic reminders were sent by SRI on May 20. On May 23 and 24, attempts were made to reach nonrespondents by telephone. On May 31, the last day of the OMB-approved survey period, the instruments were taken off the Web, and no further follow-up attempts were made.

Table 2.1 displays the populations, samples, response rates, and effective samples for the teachers we surveyed. As the table indicates, strong response rates were achieved, with 78% of teachers in the Trained Teacher sample and 92% of Active Data Providers providing survey responses (for 81% overall). Among the international partners, 28 surveys were returned to the GLOBE Assistant Director for International Programs, for a 93% response rate.

Table 2.1
Teacher Survey Populations and Sample Sizes

Population	***Population Size***	***Target Sample***	***Number Responding***	***Response Rate (percent)***	***Percent Responding on Web***
1995 GLOBE-Trained Teachers	1,659	400[2]	310	78	36
U.S. Active Data Providers	250	250	229	92	59
International Active Data Providers	30	30	28	93	NA[3]

[2] Includes 69 teachers classified as Active Data Providers.
[3] International teachers surveyed by their country coordinators. Web version of survey not available.

Among U.S. teachers responding to our survey, 44% used the World Wide Web version and 56% submitted print surveys. These overall figures mask differences in the two teacher samples, however. Members of the Trained Teacher sample preferred the print version by more than a 2:1 margin (69% versus 31%). Active Data Providers (who are submitting data through the Web), on the other hand, were more likely to opt for the Web version of the survey—60% choosing the Web over print. (International teachers were surveyed through their country coordinators and did not have the Web option.)

Teacher responses to the survey items are discussed in subsequent chapters, and the full set of responses is provided in the Data Appendix.

Student Surveys and Assessments

Student surveys and assessments were designed to elicit students' perceptions of what they have been doing in GLOBE, their attitude toward GLOBE activities, and an initial assessment of what they are able to do in areas of measurement and reasoning about earth science topics after some exposure to GLOBE. To provide representation of the broad range of ages included in the GLOBE program, we chose to survey 4th-, 7th, and 10th graders, thus representing the three U.S. school levels (elementary, middle or junior high, and secondary) and corresponding to grade levels included in many major national and international assessments.

Because we did not want to ask students who had had only limited exposure to GLOBE about the program, we chose to obtain our student sample from classrooms taught by teachers who were Active Data Providers. Teachers in that group were asked to give the student survey to all the students in their single most active GLOBE class or club if those students were 4th-, 7th-, or 10th-graders. Table 2.2 shows the student samples obtained through this procedure. As shown in the table, we obtained many more 4th-graders than students from the other two grades. Data from the representative Trained Teacher sample on the number and grade level of students in their classes (discussed in Chapter 4) suggest that this outcome reflects the GLOBE U.S. student population. Nevertheless, there are issues concerning potential sample bias in the surveyed students. In general, the reader of this volume should remember that the student survey responses were gathered from students in 73 of the most active GLOBE classes and perhaps from a teacher- or self-selected subset of these. Hence, student attitudes and experiences are likely to be more positive than those of a sample of students from all GLOBE classes, but a reasonable representation of what can be obtained as the program is implemented more thoroughly. Student responses to the survey items are discussed in subsequent chapters, and the full set of responses is provided in the Data Appendix.

Table 2.2
Sample Sizes for Student Survey and Assessment

Grade Level	*Teacher-Reported Population*	*Number of Students Reporting*	*Number of Schools Represented*	*Percent Reporting on Web*
Fourth Grade	2,410	771	38	13
Seventh Grade	1,116	237	18	8
Tenth Grade	696	114	17	43

Because the first objective of the GLOBE program is to increase student achievement in science and mathematics, we concluded that the evaluation must provide measures of student learning. Our strategy for obtaining such measures is to embed a set of assessment items within the student surveys. Because we are interested in measuring the performance of a grade-level population rather than of individuals, relatively few assessment items had to be included on each of the student surveys. Fourth-graders were given 10 assessment items and older students 15 items. We developed a framework for developing items keyed to the GLOBE science education objectives. These items cover both specific science content areas and general skills associated with measurement, data analysis, and experimental control. In collaboration with Jim Lawless, the GLOBE Chief Scientist, we developed initial pools of items (one for 4th-graders and one for 7th- and 10th-graders) appropriate for the Phase I GLOBE activities, from which samples of items could be pulled for the GLOBE student surveys. In developing assessment items, we took care to develop items that tested more than factual information. Typically, the items provided a context including an illustration or set of data with one or more questions addressing this problem context. Some of the items were modifications of items used on earlier state, national, or international assessments. Items that appear to work well in the spring 1996 administration will be used along with items developed for the Phase II GLOBE materials in a “pre-post” design during the 1996-97 school year. Because we will be using the assessment items in subsequent years, they are not presented in the Data Appendix, but student responses to the items are described in Chapter 5.

Case Studies

Our research plan included site visits and the development of snapshot case studies for five core sites. We wanted to select sites that would represent the range of grade levels and geographic distribution within GLOBE and that would also represent those schools believed to be implementing GLOBE in a serious way. Such schools are most apt to have experiences and strategies from which other schools can benefit. We obtained records of the schools contributing the most data to the database in the fall of 1995, as well as nominations from GLOBE trainers and science principal investigators concerning exemplary GLOBE teachers. We conducted phone interviews with the 20 sites so identified, and on the basis of their interview responses selected 5 sites that provided geographic and grade-level representation. Site visits were conducted between March and May of 1996. Each visit was scheduled for a 3-day period and included interviews of GLOBE teachers, observations of GLOBE activities, informal discussions with students, and interviews with administrators who had been most involved in getting the program in place within the school.

In addition to the five core sites, we also identified nearby sites that could be visited more briefly during the same visit. These neighboring sites gave us a picture of the concerns and outlook of sites where the program was not necessarily producing large amounts of data. Illustrations from both groups of sites are included in the remaining chapters of this report. The teacher interviews and classroom observations from the five core sites (with identifying information removed) are included in the Data Appendix.

Chapter 3. Growth of the Program

In this chapter, we describe GLOBE's first-year experience with teacher training and student data collection. This information is based on databases developed and maintained by the GLOBE program.

Growth in Number of Teachers Trained

The first set of U.S. GLOBE teachers was trained in March 1995, and training sessions were conducted in the summer and fall of that year. Training sessions resumed in January and February 1996, and then again in the spring and summer of 1996. When teachers have completed their GLOBE training, their school site is assigned a unique site identification number to be used by the GLOBE teacher and students for reporting data and for accessing information on the GLOBE Web site. This number is added to the school's data in the NOAA Master Database. This procedure allowed us to use the database to compile data on the number of teachers trained by counting only those teachers with an assigned site identification number, eliminating from the count those teachers shown as scheduled for training but having no site identifier.

Figure 3.1 shows the cumulative growth in number of teachers trained, starting with 405 as the program opened in March 1995, climbing to 1,659 by December 1995, and reaching 1,992 by the summer of 1996.

Number of Reporting Schools

Before looking at the way schools reported individual types of data, we first examined the growth in the number of schools reporting data of any kind to GLOBE. For this information, we used daily and weekly summaries of data in the Student Data Archives, going back to the first set made available to us by NOAA. We then grouped the summaries into monthly sets.

Figure 3.1
Cumulative Growth in Number of Teachers Trained for GLOBE

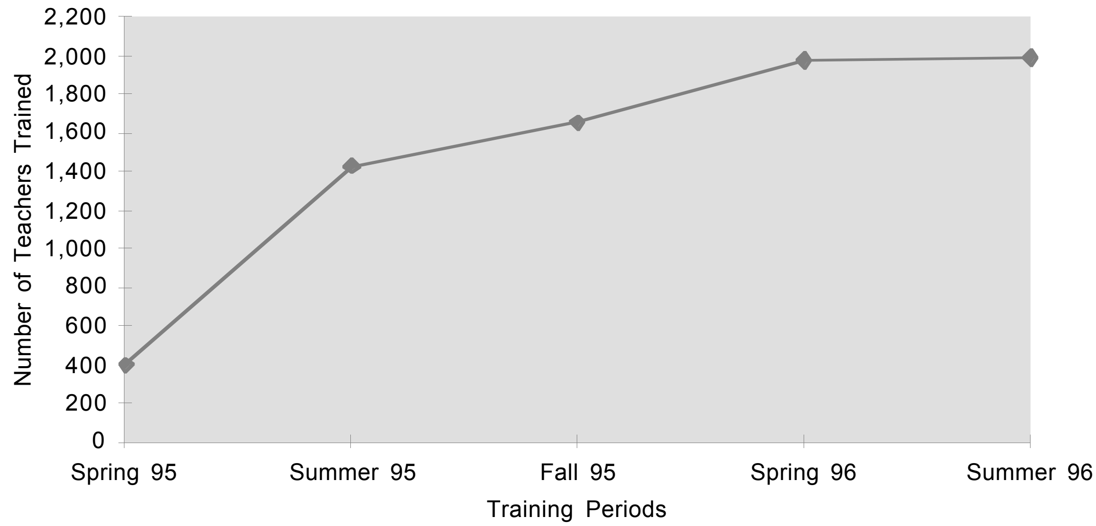
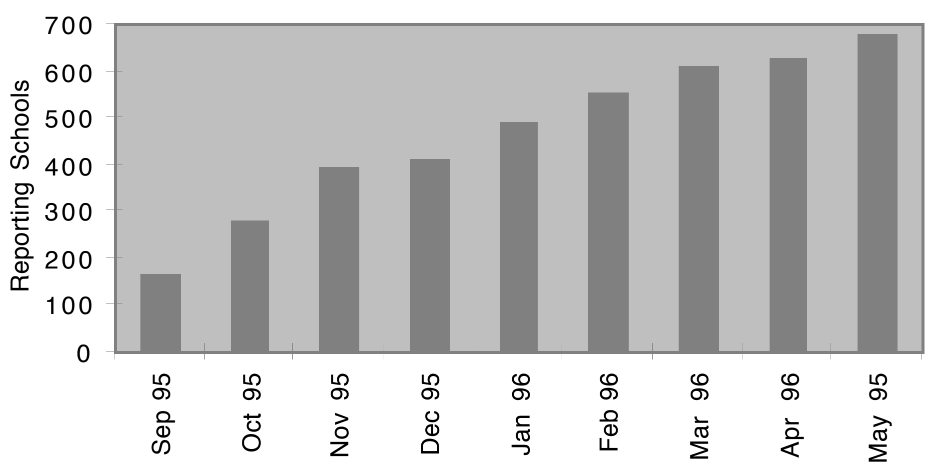


Figure 3.2 provides a monthly total of the U.S. schools submitting GLOBE observations for the period September 1995 through May 1996. As shown, there was a steady increase in the number of schools reporting data during the school year, growing from an initial 167 in September 1995 to 675 schools in May 1996. Over roughly the same time period, the number of international schools reporting data grew to 173 (from 19 different countries).

Figure 3.2
Number of U.S. Schools Submitting Observations, by Month



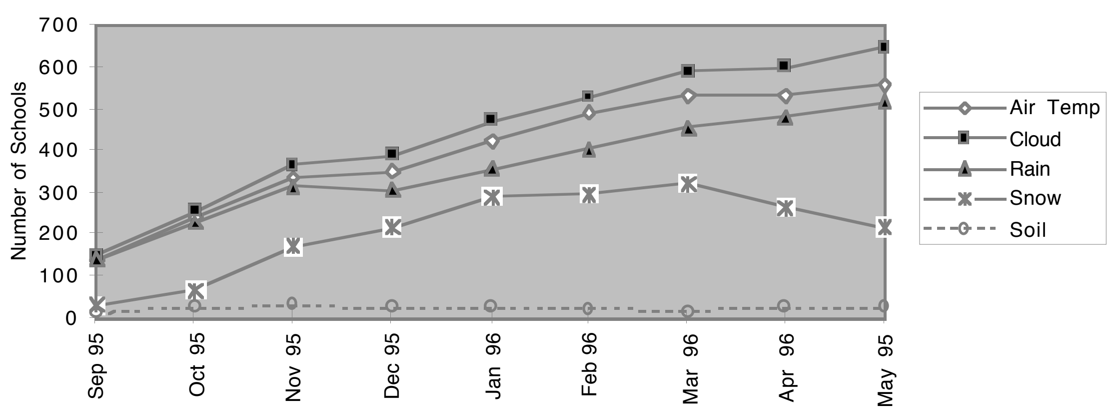
Reporting Patterns

Students are directed to take measurements and submit data according to a schedule established for each protocol. For example, GLOBE recommends that air temperature, cloud cover, and rain and snow precipitation be gathered on a daily basis. Soil moisture is gathered on a daily basis by high school students only. Water temperature is taken on a weekly basis. Biometric information, including ground and canopy cover, is gathered on a seasonal basis, except for tree diameter and height, which have to be measured once a year. Identifications of animal and bird species are submitted annually, and land cover information is gathered just once, at the time a school implements its site.

Air temperature, cloud cover, and precipitation are generally the first measurements introduced to GLOBE students since they require less site preparation than the other measurement protocols. As might be expected, these are the data that are reported by the most GLOBE schools. Figure 3.3 shows the number of schools reporting these data, by month, during the period September 1995 through May 1996.

As shown in Figure 3.3, the number of schools reporting data at least once for the first three types of daily measurement—air temperature, cloud cover, and rainfall—increased throughout the period. The level of reporting and its increase are quite similar for these three data types. However, for snow and for soil moisture data, the reporting rates are lower and follow different patterns.

Figure 3.3
Number of U.S. Schools Submitting Observations, by Month and Data Type

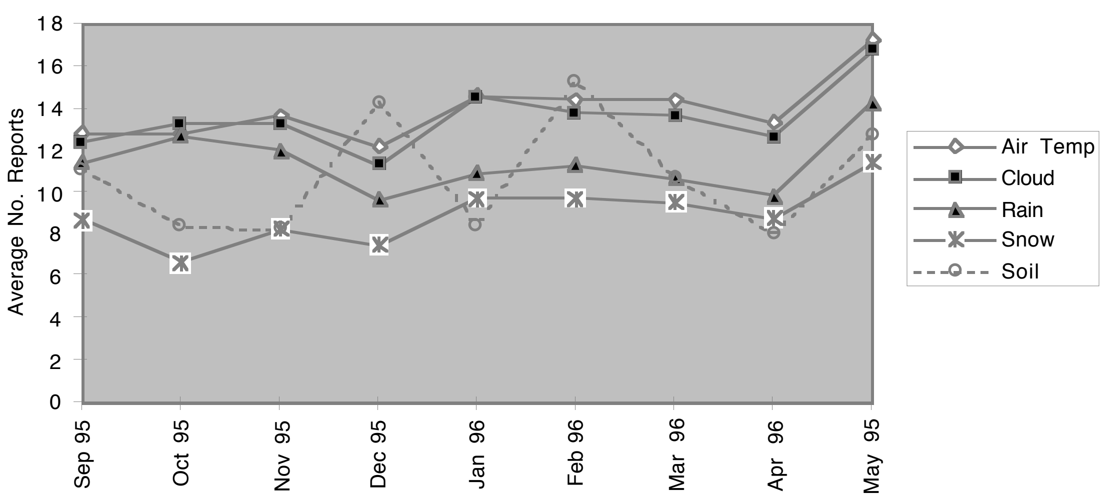


In part, the number of schools submitting observations on soil moisture is lower because only high school students are expected to submit these reports. However, implementation of the Phase I soil moisture protocol requires rather extensive site preparation and a complex calculation of a calibration curve, and this requirement may also be reflected in the low number of reporting schools.

The number of schools reporting some data does not tell the whole story, of course. Some schools may report only a few observations. We next looked at the average numbers of observations that can be performed daily (i.e., observations of air temperature, cloud cover, precipitation, and soil moisture) that were submitted by schools. The results are displayed in Figure 3.4. Again, these data are shown by month.

For each type of data except soil moisture, the average number of observations submitted during a monthly period varied very little, although the data show that schools submit more air temperature and cloud cover data than any other daily measurement data. The average number of soil moisture reports tends to show more variation by month. Because there are fewer schools, by far, contributing to the calculation of average number of reports per school for soil moisture, a greater degree of variability is not surprising.

Figure 3.4
Average Number of Observations Per Reporting School, by Month and Data Type



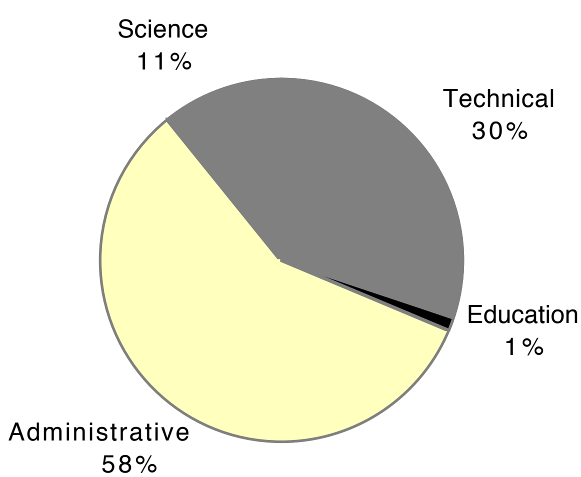
Help Desk Inquiries

Data on counts of Help Desk queries from April 1995 to February 1996 have been provided to the evaluation by NASA-Ames, where the Help Desk staff are located.

The data show frequent use of the Help Desk facility. Most people contacting the Help Desk did so through the telephone hotline; a total of 2,292 queries were received this way in the 11-month period. Other requests were sent via electronic mail (295 queries) and through the GLOBE Web site (212 queries). As more of the GLOBE teachers become familiar with, and access, the GLOBE Web site, we would expect requests for information and help to shift from telephone calls to Web access.

Figure 3.5 shows the types of information requested in these calls. Most (58%) involved queries of an administrative nature, including questions about training, how to acquire GLOBE materials, how to get SLIP access, and how to get a school identification number. The next significant set of questions (30%) centered on technical concerns—questions about network applications, the Internet, the World Wide Web, or TCP/IP stacks. Third were questions relating to science, and these nearly all related to instrumentation and data entry rather than to the sciences themselves. Finally, there was a very small set of questions—20 in all—that related to education. Almost all of these related to education activities or using the Internet for education.

Figure 3.5 Help Desk Inquiries, by Type



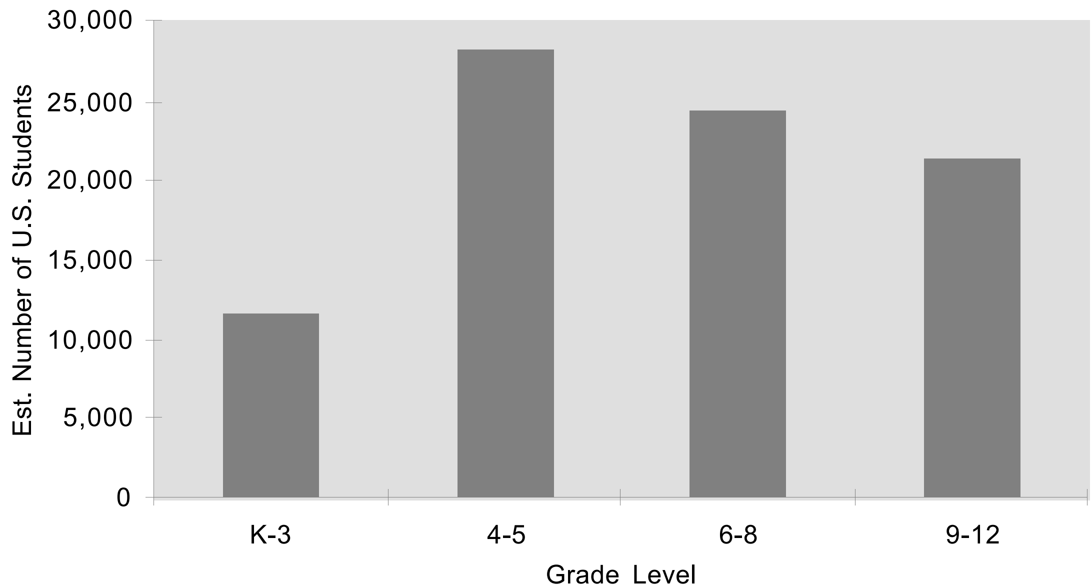
The Help Desk queries provide insights regarding the areas where teachers need assistance in getting started with GLOBE. Our teacher surveys provide additional information on this topic, as discussed in Chapter 5. Further, the surveys show that a remarkably high proportion of GLOBE teachers who actually implemented the program used the Help Desk at least once (86%). Moreover, with a few exceptions, write-in comments suggested a high degree of satisfaction with the service provided.

Chapter 4. Characteristics of GLOBE Students and Classrooms

Estimated Population of Active GLOBE Students

The responses of teachers in our representative Trained Teacher sample provide the basis for estimating the number of U.S. students who participated in GLOBE during the 1995-96 school year. Teachers were asked to indicate the number of students participating at their schools within four broad grade-level bands (K-3, 4-5, 6-8, and 9-12). Applying weights to these numbers to generate population estimates, we estimate more than 85,000 students in the United States participated in GLOBE during its first full year of implementation.[4] Our estimates for the number of students across the four grade ranges are illustrated in Figure 4.1. These projections suggest that the greatest concentration of U.S. GLOBE students is in grades 4 and 5.

Figure 4.1
Estimate of Number of U.S. Students Participating in GLOBE, by Grade Level Range



[4] Since the total number of U.S. teachers trained in 1995 was 1,659 and the number of teachers in our effective sample was 310, we multiplied the total number of GLOBE students in the schools where our sample teachers teach by 1,659/310, or 5.35, to generate population estimates.

The sample design for the International Teacher Survey does not support an estimate of the international GLOBE student population.[5] However, we can note that the 28 sampled international teachers are in schools in which 1,590 students participate in GLOBE activities and that these students are distributed across the age ranges in our grade level categories as follows: <1% ages 5-8 (corresponding to K-3 in U.S. schools), 9% ages 9-10, 40% ages 11-13, and 50% ages 14 and above. Although we cannot draw definitive inferences about international students participating in GLOBE, we can say that among Active Data Providers, international students tend to be 3 to 4 years older than their U.S. counterparts.

School Implementation Patterns

Because our Trained Teacher sample is representative of all U.S. schools participating in GLOBE, we will use that data set as a basis for explicating the characteristics of U.S. GLOBE schools and classrooms (except where otherwise noted). The schools represented by the teachers in this sample are 94% public and 96% "regular" (as opposed to "alternative"). In terms of setting, 44% of teachers described their schools as located in a rural area, 35% suburban, and 21% urban. (In contrast, 37% of the teachers in our international sample described their setting as urban.) An indication of the extent to which the program has permeated U.S. schools serving large proportions of children from low-income homes can be derived from teachers' estimates of the proportion of their students who qualify for free or reduced-price lunches: 25% of GLOBE-trained teachers implementing the program estimate that 50% or more of their students qualify (these would be considered high-poverty schools); 29% estimate that fewer than 15% of their students qualify (these would be considered low-poverty schools).[6]

Responses of our Trained Teacher sample indicate that in most U.S. GLOBE schools (72%) a single teacher is involved in implementing the program. Two teachers are involved with the program in a reported 14% of schools, three teachers in 6%, and four or more teachers in 8%. Among the U.S. Active Data Providers, 66% have a single GLOBE teacher, 16% have two, and 18% have three or more teachers involved. Internationally, multiple teachers in a GLOBE school are more commonplace; 71% of the very active

[5] We could not compute comparable estimates for GLOBE students internationally because we did not have a representative sample of all teachers trained in GLOBE outside the United States.

[6] The proportions of urban schools and of schools serving 50% or more low-income children are lower among Active Data Provider schools.

international GLOBE schools have two or more GLOBE teachers. Thirty percent of both U.S. and international teachers report that schools within their district are cooperating in the implementation of GLOBE activities. Larger-scale implementations are in the planning stages. One Finnish school district, for example, expects to implement GLOBE in all its schools so that students can participate from age 7 through 18.

Most U.S. teachers (80%) reported implementing GLOBE within a regular classroom; 27% reported conducting some lunch or after-school activities; 25% described their program as including time where students were pulled out of regular classes. International GLOBE teachers are somewhat more likely to teach GLOBE as a lunch or extracurricular activity and somewhat less likely to teach it within a regular class. Teacher reports of the number of students they worked with in their most active GLOBE class or group suggest that U.S. teachers have been working with full classes: the average is 28 students. In the international sample, on the other hand, most teachers reported working with fewer than 20 students in their most active GLOBE group.

Teachers were asked also to indicate the various types of classes within which GLOBE was being implemented at their school. The most common type of class indicated by U.S. teachers trained by GLOBE was comprehensive elementary class (34% reporting), followed by classes in environmental science (16%), earth science (13%), general science (13%), and biology (11%). In keeping with their older student population, international teachers were less likely to report implementing GLOBE in elementary school classes and more likely to report incorporating it into environmental science or biology classes.

Estimated Frequency of GLOBE Activities

The data presented above provide a picture of the number of schools, teachers, and classes that have had some kind of involvement with GLOBE. We wanted to go beyond this general picture to obtain an understanding of the aspects of GLOBE that teachers are implementing and a sense of the extent to which all the students in the class, as opposed to a small handful, are involved in meaningful activities. As one teacher who has not yet implemented the program put it, “The biggest problem I foresee is getting 25-30 students actively involved when it takes only a few to do the data gathering.”

Table 4.1 summarizes the responses of the Trained Teacher sample to questions about the number of students who engage in various types of GLOBE activities in their classroom during a typical week. As a point of comparison, Table 4.2 presents the same data for the sample of Active Data Providers, who provide a picture of the nature of GLOBE in schools that are more actively implementing the program.

Table 4.1
Trained Teacher Reports of Student Participation in GLOBE Activities in a Typical Week

GLOBE Activity	Percent Reporting			
	No Students	1-4 Students	5-10 but Not Whole Class	Whole Class or >10
Take a measurement	3	32	35	30
Enter data on computer	24	44	20	12
Use visualization software	61	16	14	9
Compare different sets of GLOBE data	55	15	13	17
Predict how data might change over few weeks/months	57	10	9	24
Help other students with GLOBE	37	35	16	13
Write about GLOBE activity or data set	64	12	6	18
Telecommunicate with other GLOBE schools	71	17	9	3
Talk/interact with a scientist	89	3	3	4

Sample sizes: $206 \leq n \leq 217$

As one would expect, taking GLOBE measurements is the most fully implemented aspect of the program, with only 3% of the portion of the Trained Teacher sample who say they are implementing GLOBE indicating that no students participate in this activity in a typical week. Entering GLOBE data on a computer is the next most fully implemented component, with 24% of the Trained Teacher sample and just 3% of Active Data Providers indicating that no students do this in a typical week. Helping other students with GLOBE is also a very common activity within GLOBE classrooms.

Other aspects of the program are less widespread. Sixty-one percent of Trained Teachers and 40% of Active Data Providers indicated that no students used the visualization software in a typical week; the corresponding percentages for telecommunicating with other GLOBE schools were 71% and 50%, and for comparing different sets of GLOBE data, 55% and 39%. Similarly, elaborations and enhancements around GLOBE do not appear as common as one might like: 57% of Trained Teachers and 55% of Active Data Providers reported that none of their students made predictions about GLOBE data in a typical week; the corresponding percentages for writing about a GLOBE activity or data set were 64% and 54%, and for talking or interacting with a scientist, 89% and 86%.

Table 4.2
Active Data Provider Reports of Student Participation in GLOBE Activities in a Typical Week

	Percent Reporting			
GLOBE Activity	***No Students***	***1-4 Students***	***5-10 but Not Whole Class***	***Whole Class or >10***
Take a measurement	0	28	40	32
Enter data on computer	3	48	32	17
Use visualization software	40	31	17	13
Compare different sets of GLOBE data	39	24	21	16
Predict how data might change over few weeks/months	55	14	11	20
Help other students with GLOBE	29	37	22	12
Write about GLOBE activity or data set	54	16	11	19
Telecommunicate with other GLOBE schools	50	33	11	7
Talk/interact with a scientist	86	9	3	2

Sample sizes: $216 \leq n \leq 225$

Another perspective on this issue is available through examining the responses of the students themselves. Active Data Providers among U.S. teachers were asked to administer student surveys to the 4th-, 7th-, and 10th-graders in their most active GLOBE class. Table 4.3 shows the percentage of these students who indicated that they engaged in each GLOBE activity some time during the week before they completed the survey.

In keeping with the teacher reports, the most common activity cited by students was taking a measurement, reported by 55% of 4th-graders and 65% of the older students. About half of the students reported having helped other students work on GLOBE the prior week, and 42% of 4th-graders and 48% of older students said they had entered

Table 4.3
Student Reports of Participation in GLOBE Activities during the Prior Week

Activity	*Percent of 4th-Graders Reporting*	*Percent of 7th/10th-Graders Reporting*
Took a measurement	55	65
Entered data on computer	42	48
Compared GLOBE measurement to data your class collected some time in the past	24	31
Talked about how something class measures for GLOBE might change in future	32	34
Compared GLOBE data your class had collected to data from another site	NA	21
Helped other students work on GLOBE	49	50
Used the computer to send messages to students at another GLOBE school	29	24
Used the computer to send a message to a scientist	10	13
Talked to parents or other adult about what you do in GLOBE	52	55
Did something to improve the environment around school or community	NA	32
Wrote something about GLOBE	36	32

Sample sizes: 4th grade = $634 \leq n \leq 729$
7th/10th grade = $345 \leq n \leq 349$

NA = Not asked.

GLOBE data on a computer. In these active classes, sizable proportions of students reported having talked about how something the class measures might change in the future, writing about GLOBE, and sending messages to students at another GLOBE school. Sending an electronic mail message to a scientist was not a common activity (reported by 10% of 4th-graders and 13% of older students), which is not surprising given that the GLOBE server does not support this function directly. We did obtain records of such exchanges involving some of our case study sites, however, as illustrated in Exhibit 4.1.

Older students were asked whether they had compared their GLOBE data with that from another site, and only 21% said that they had done so the prior week, suggesting that the data archives and visualizations are not being exploited to their full potential. Finally, an unexpected but encouraging finding was the fact that the second most commonly reported activity among students (second only to taking measurements) was talking to parents or other adults about GLOBE: 52% of 4th-graders and 55% of the older students said that they had done so the prior week.

The Organization of Instruction in GLOBE Classes

In addition to indicating the extent to which certain components of GLOBE are implemented (or not) in a typical week, the data in Tables 4.1 and 4.2 can be used also to draw inferences about classroom management practices or the organization of instruction within GLOBE classrooms. At issue is whether a few students are entrusted with a given component of GLOBE or all students are rotated through a range of activities.

Our sensitivity to this issue was raised during the course of identifying schools as case study sites. As described in Chapter 3, we began with a set of schools that were among the heaviest contributors of GLOBE data. In early phone interviews, we identified one high school where a single student was carrying on the program after the departure of the GLOBE-trained teacher. At another high school, a group of three students had conducted the vast majority of the data collection and reporting. For this reason, teacher strategies for organizing GLOBE activities and for involving all students in analysis and interpretation as well as data collection were of particular interest during our site visits. These strategies are discussed in the next chapter.

Even among the Active Data Providers, 28% of teachers report that only 1 to 4 students are involved in taking GLOBE measurements and 48% that only 1 to 4 students are involved in entering data on the computer in a typical week. What the survey data do not tell us is whether teachers are rotating different sets of students through these activities or relying on the same students week after week.

Exhibit 4.1
Example of Electronic Communication with Scientists
(Excerpts)

Subj: 24 Personal Thank Yous
Date: Thu, May 25, 1995 3:07 PM PDT

It is most encouraging to receive 24 personal - handwritten thank you letters!

Geography-meteorology-weather-climate-soils-botany-ecosystems-biodiversity are FUN! The fun is asking hard questions, finding some answers and more questions and always being able to learn more. The fun is in putting math, English, spelling, drawing, thinking, computers, air, sun, wind, elevation, latitude, aspect, statistics, physics and chemistry TOGETHER - and finding answers that make sense to us and others. Bill Nye the Science Guy has FUN.

Part of the fun is sharing the curiosity, knowledge and results, then taking on new problems and moving forward together. Part of the fun for me was visiting your class and seeing some of your tools, sharing your enthusiasm, and some of your results.

It is wonderful to have both girls AND boys equally knowledgeable and interested in science! It is GREAT visiting your weather instrument shelter and computer lab, seeing 1 meter transects being actively done on the school ground and observing how you ground-truth and measure your school.

Response to some questions:

1) A single graph can take about 20 minutes. It took 5 years in some cases, to figure out how to put the pieces of the graphs together so they are in just the right place. There is no magical software to do the graphs. They are all done in Claris Draw (MacDraw). Many of the graphs make use of color for dots, lines and polygons. A wonderful tool of science is the Macintosh! Even most college-level text books will not tell you how to do the graphs - you must figure things out for yourself! (I am always looking for ways to make the graphs better).

Exhibit 4.1
Example of Electronic Communication with Scientists
(Excerpts continued)

I use a lot of trial and error. I give copies of graphs to students and other scientists. They look at the graphs and make suggestions, ask hard questions, and I do the graphs again. Much of what you received in class is the 20th version of the graph! The original climate classification graph was actually made UPSIDE DOWN in the book where it is first published (on the Y-axis, zero (0) is at the top. I changed the graph so zero (0) is now at the bottom). This is a simple change, but it even took me 5 years before I noticed zero was in the wrong place!

For the 480-month (40-year) study of climate of the San Joaquin Valley and Sierra Nevada, each of the 31 climate stations has more than 20 graphs. Some are generated through statistics software (Statview 4.1), some are drawn using a mouse and Claris Draw, there are a LOT of graphs. The graphs make it easier to understand the thousands of pages of numbers.

2) I am a full time climatologist, one of two climatologists employed by the insurance industry (the other is Kris Lynn, another geographer). We both work with soils, climate, weather, statistics, geographic information systems (GIS), cartography (maps), computers, spreadsheets, CD-ROMS, and all kinds of tools and information. We both teach part-time at Fresno City College (Weather and Climate, Landforms, Regional Geography) - our next course starts in about one week.

3) It took a long time to become a geographer-climatologist. I am now a “Scholar” - I continue to take classes, read books, do research, do homework, subscribe to journals, learn and relearn, and learn from students like you. Life is exciting. A good scholar must be able to bring in-depth knowledge from at least two fields to the table. Geography is an “umbrella” of knowledge - all the pieces somehow fit together.

Thank you for your wonderful energy, enthusiasm, thirst for knowledge and great thank yous!

Scott Kruse - biophysical geographer and climatologist

Chapter 5. Implementation Challenges and Strategies

With its combination of rigorous scientific protocols, use of recently developed network technology, and hands-on science pedagogy, GLOBE is both exciting and challenging from a teacher's perspective. In this chapter, we examine the challenges GLOBE, poses first in terms of their effects on a group of teachers who received GLOBE training but did not implement the program with their students during the 1995-96 school year and then as they have been experienced by those teachers who did get the program up and running.

Trained Teachers Who Have Not Implemented GLOBE with Students

A basic evaluation question is the extent to which GLOBE-trained teachers actually implement the program with their students. By including those teachers who had not implemented the program in our Trained Teacher sample, we sought to gain insights into the concerns and barriers that had kept them from putting the program into practice.

Among the teachers in our Trained Teacher sample, 90 teachers (29% of respondents) said that they had not been implementing the program with students. The major barriers that these teachers reported as keeping them from implementing GLOBE are listed in Table 5.1.

As Table 5.1 shows, the largest perceived barrier was absence of the network and computer infrastructure needed to fully implement GLOBE (i.e., Internet access, dedicated phone line, hardware and software). The second major category of barrier concerned time: first, the time needed to plan and set up for the program (cited by 37%) and then the blocks of time needed in the school schedule (27%). Exhibit 5.1 displays some of the comments from teachers who chose to write in descriptions of problems they had faced, in addition to the barriers on our checklist.

A positive sign for the program is that only a very small fraction of the teachers (4%) who had failed to implement the program by the spring of 1996 cited either lack of confidence in their ability to take the measurements correctly (a gauge of the success of the training) or questions about the suitability of the program for their students as a major barrier. Another finding is that 95% of these nonimplementers reported that they did expect to implement GLOBE in the future. Roughly one-third of these expected to begin activities later in the spring or in the summer of 1996; the remainder anticipated beginning in the fall of 1996.

Table 5.1
Problems Rated as "Major Barriers" by Trained Teachers Not Implementing GLOBE with Students

Barrier Rated as "Major"	*Percent Reporting*
Lack of Internet access	46
Lack of time to plan & implement	37
Lack of phone line	31
Difficulty fitting into school schedule	27
Lack of computer hardware/software	20
Difficulties integrating into existing curriculum	18
Difficulty identifying an appropriate site	13
Lack of technical support	12
Lack of confidence in ability to take measurements correctly	4
Concern about whether GLOBE would be valuable for my students	4

Sample sizes: $80 \leq n \leq 85$

Teachers who had not begun implementing GLOBE with students were asked also what actions the GLOBE program could undertake to increase the likelihood that they would implement the program with their students. Table 5.2 shows responses to this item.

The responses in Table 5.2 are consistent with the cited barriers in suggesting that teachers who are not implementing GLOBE would like help obtaining full Internet access. The second biggest help that GLOBE could offer, according to these teachers, would be some kind of local training session in which they could interact with other GLOBE teachers. As one teacher wrote, "Teachers need planning time with other colleagues for GLOBE. Refresher type course on the Internet and using GLOBE training."

We did not survey a comparable sample of international teachers who had received GLOBE training but had not yet implemented the program. Indications of barriers confronting teachers outside the United States were addressed, however, in interviews with country coordinators for 10 of the international partners. Seven of the coordinators reported that Internet/WWW access had been a significant challenge for GLOBE schools within their countries. (In some cases, the major issue was the high cost of connection time; in one case, the problem was lack of any Internet access within the country.)

Exhibit 5.1
Examples of Problems Experienced by Teachers Who Have Not Implemented GLOBE with Students

The few times I tried to use the Internet I was denied access.

There is major construction at our school. It has made it difficult to find permanent sites for taking measurements.

It took so long into the school year to get all the necessary aspects of the program in place that much of the year was gone and I could not get everything worked out.

Thought measurements were too specific.

Our superintendent has been trying to get unlimited Internet access via our local college, but has encountered problems. Rather than settle for a costly limited access to Internet. . . he is pursuing access via the [state] Dept. of Education, which looks promising.

One phone line is being used by 3 rooms. Internet access providers system is often down or busy.

Obtaining all necessary equipment.

New science teacher was hired after other teacher received GLOBE training. His load was too heavy to have time for training and to implement GLOBE. A weather station was built near river, but vandalism has been a major problem.

Table 5.2
Actions That Would Increase Likelihood of Implementing GLOBE with Students

Action Rated as "Big Help"	*Percent Reporting*
Help obtaining World Wide Web connection	48
Local training session with other teachers	39
Help obtaining computer equipment	25
Call from GLOBE computer technician	19
Guidance in relating GLOBE to their curriculum	13

Sample sizes: $63 \leq n \leq 69$

Perceptions of Teachers Who Have Implemented the Program with Students

Another perspective on the challenges posed by GLOBE is provided by the responses of those teachers who have been implementing GLOBE with students. We would expect these teachers to cite some of the same issues that were seen as barriers by those who had never gotten to the point of working with students on GLOBE, but with program experience, the hurdles to getting the program up and running initially may seem less daunting and additional issues may well emerge. From the Teacher Survey, we have data both for those members of the representative sample of Trained Teachers who had implemented the program with students and from the sample of teachers who were Active Data Providers. Their insights are supplemented with discussions from interviews with case study teachers.

Table 5.3 presents the ratings teachers in the two survey samples gave for various challenges they faced in implementing GLOBE within their schools. Not surprisingly, the sample of teachers whose schools are the most active data contributors regard fewer challenges as "major." Nevertheless, there is good agreement across the two samples in terms of the issues teachers find most pressing. Clearly, obtaining measurements on weekends and during vacations is a challenge within an institution that runs on a Monday through Friday schedule. Teachers have developed a number of strategies for coping with the problem, for example, by using a rotating set of student or parent volunteers, but this requirement remains one that involves considerable effort and attention.

Table 5.3
Factors Rated as a "Major Challenge" in Implementing GLOBE

Challenge	*Percent of Trained Teachers Reporting*	*Percent of Active Data Providers Reporting*
Accessing instruments for data collection on weekends, vacations	50	45
Fitting activities into school schedule	45	35
Finding time for GLOBE, given other curriculum and testing requirements	42	37
Finding time to prepare for implementing GLOBE	40	33
Getting to the data collection site	30	21
Getting access to adequate computers	25	17
Getting computer technical support	24	10
Logging onto GLOBE server	23	12
Assessing what students are learning from GLOBE	22	19
Integrating GLOBE with the rest of the curriculum	20	18
Securing GLOBE equipment	19	19
Finding funds to purchase scientific measurement instruments	14	14
Presenting activities at right level for students	14	11
Obtaining support from administrators, other teachers	13	11
Getting measurement equipment to work properly	8	4
Maintaining good student behavior during GLOBE activities	8	4

Sample sizes: Trained Teachers, $173 \le n \le 216$
Active Data Providers, $197 \le n \le 221$

Next to this issue of the mismatch between a scientific data collection schedule and the schedule on which schools run, the major perceived impediments all have to do with time in one respect or another. Completing GLOBE activities within the confines of a school schedule, with 40- to 50-minute instructional blocks as the norm, is a major challenge in teachers' minds. Another is finding a place for GLOBE, given the pressure to cover so many other curriculum topics and the requirements of testing programs. Finally, the demands that GLOBE makes on the teacher's time, given the requirements for preparation and support activities, are seen as a major challenge.

Interestingly, although computer access and technical problems are seen as major challenges by a significant fraction of these teachers, they are not as prominent as in the minds of teachers who have not yet implemented the program with students. Not surprisingly, those teachers whose students have contributed the most to the GLOBE database are less likely to see these technical issues as major barriers (17% of Active Data Providers versus 25% of the Trained Teachers implementing the program). Of greater concern to the Active Data Providers are the pedagogical issues of assessing what their students are learning from GLOBE and integrating GLOBE with the rest of their curriculum. We might expect that as more teachers gain extensive experience with the program, the technical issues will fade in importance for, them too, and they will be able to devote more of their time and energy to tackling challenges related to providing the highest-quality instruction.

Trailing the list of the challenges we asked teachers to rate are problems with getting the scientific equipment to work properly and difficulty maintaining good student behavior during GLOBE activities. These reports should be encouraging to those teachers who have not yet implemented the program and who may have some anxiety about these factors.

Like their U.S. counterparts, international GLOBE teachers rate the logistical challenges of data collection over weekends and vacations and fitting GLOBE activities into the school schedule at the top of their list of barriers (with 39% rating the first and 29% rating the second as "major barriers"). International teachers are somewhat more likely than their U.S. counterparts to find fitting GLOBE into the rest of the curriculum a major problem (28%, compared with 18% for U.S. Active Data Providers). They are somewhat more likely also to regard presenting GLOBE activities at the right level for their students as a major barrier (at 18%, compared with 11%). This perception may be related to the fact that their students tend to be older.

Strategies for Coping with Implementation Challenges

Weekend and Vacation Measurements. Providing adequate data collection over periods when school is not in session is viewed as the single biggest challenge by teachers implementing the GLOBE program. Although there is no easy answer to the fulfillment of this responsibility, many teachers have developed GLOBE support structures that involve student service clubs, provision of extra credit or recognition for data collection during nonschool hours, and the active participation of parents. Exhibit 5.2 highlights some of these approaches. One of the sites in particular had an active program involving 18 families in the collection of GLOBE data. For that school, GLOBE had become a major part of their overall parent involvement strategy and was perceived as having strengthened the linkages between the community and the school.

Exhibit 5.2
Strategies for Collecting GLOBE Data Outside of School Hours

A 9th-grade general science teacher developed a variety of strategies for collecting GLOBE data over the summer of 1995. For part of the time, a high school senior collected the data for extra credit. Over a 2-week period, an elementary school teacher and her students took over the data collection. A Cub Scout pack and a Girl Scout troop each took on a week's worth of data collection.

At an elementary school, the GLOBE teacher organized an effort for 18 families to collect GLOBE data on a rotating basis over the summer and on weekends. The teacher trained the families and distributed information sheets about the protocols for later reference. During their shift, each family took the measurements and then phoned them in to the teacher. Over the summer, families participating in this effort would pick up and drop off the key to the weather station at the Village Office. When parents found they could not fulfill an obligation to take a measurement, they called one of the other families to obtain a substitute. The GLOBE teacher made an effort to express his appreciation for the parents' support, and extensive publicity about GLOBE activities in the local and school newspapers made them feel that they were part of a community effort.

Finding Time for GLOBE Activities. Although it does not take long to execute the daily GLOBE measurements, it does take time to provide an educationally rich context around those measurements, providing students first with an understanding of the significance of the variables they are measuring from an earth systems viewpoint and an appreciation of why the measurement protocols must be followed as they are specified, and then with time to reflect on the data they have collected, assessing their reasonableness and comparing them with predictions, past data, or data from other sites. Transportation to remote sites can require significant time as well. GLOBE teachers at schools with flexible or block scheduling believe that this arrangement enhances their ability to implement GLOBE. One survey respondent wrote, “We have been very lucky. . .this year to have our team time blocked. This means that I can take the two sections of seventh graders out to the creek for two hours. We use their math time and then make it up later in the week. I wouldn’t have been able to take the kids to the creek without this. . .”

Even with flexible scheduling, teachers are still faced with the challenge of finding time for GLOBE within the academic school year, given all the competing demands of mandated curricula, other projects and special programs, and standardized testing.

In case study observations, we saw two basic approaches to dealing with GLOBE’s time requirements. The first strategy was to minimize the impact of the program on class time. A school club or small group of lunch-time volunteers would perform the daily measurements and submit the data to the archives. In a variation of the same strategy, one teacher had rotating pairs of students collect the measurements on their way to class, causing them to miss just the first 7 or 8 minutes of class time. The advantage of this strategy was its efficiency in terms of getting the data collected; its disadvantage was that in some cases there was little educational enrichment around the data collection.

Alternatively, teachers examined GLOBE and explored ways in which the GLOBE activities fit in with the curricula they were mandated to teach. Under this strategy, GLOBE activities function as “replacement units,” a set of new activities that could be used to support learning of previously specified competencies or understandings. Examples of the way in which GLOBE has been fit into various curricula at different grade levels are provided in Exhibit 5.3.

Getting Adequate Internet Access. The GLOBE program envisions use of the Internet not only as a medium for submitting and retrieving data but also as a communication channel. Access to the Internet remains limited for many classrooms, either because of a lack of network connections or a budget to pay connection fees or because computers are lacking or technical problems lead the teacher to give up on activities such as use of MultiSpec. Many GLOBE schools are working with district or state initiatives to obtain or enhance their network connections. One of the case study sites had joined in a grant proposal to obtain an ISDN line, for example. Another was using the state educational network. A third school had been able to use Eisenhower Teacher Enhancement funds to obtain computer equipment. One survey respondent suggested that if the school does not have Internet access, parents who are on-line at home can be recruited to work with students to submit GLOBE data periodically.

Exhibit 5.3
Examples of Integration of GLOBE into Existing Curricula

The GLOBE teacher at this elementary school is responsible for teaching science to grades 1-6. The Science Curriculum Integration Study curriculum used in these classes gives little emphasis to earth science. GLOBE is seen as a way to enhance this aspect of the curriculum and also to teach weather with a "hands-on" approach. Different aspects of GLOBE are emphasized at different grade levels: seasons in kindergarten; clouds, water conservation, and tree species in first grade; water cycle and temperature in second grade; thermometer reading, ozone, and acid rain in third grade; latitude, longitude, and elevation plus seasons and temperature in fourth grade; measurement and computers in fifth grade; and pH, water quality, and marine life in sixth grade.

At a junior high school, one teaching team explored the connections between GLOBE and their mathematics curriculum. They concluded that the topics of circumference, functions, statistical estimation, graphing, and trigonometry can all be related to GLOBE data collection activities.

Several of the international country coordinators reported that GLOBE fits well with ongoing national educational initiatives in environmental science or scientific investigations. GLOBE Japan, for example, is adding social/human issues to the GLOBE activities. Students will study their local communities and environmental issues that affect their lives. One project under development is called Heat Island; students will learn how land use patterns result in higher temperatures within urban areas. Another project will tie food and culture into earth science. Students will learn how meteorology, land cover, and land use affect how people cook and what they eat. At a local level, GLOBE is being integrated into a broad range of curricula within international partner schools. Some German schools, for example, are incorporating GLOBE into foreign-language classes. The Australian GLOBE program is exploring ways to weave GLOBE-related activities into art and drama classes.

Securing GLOBE Equipment. Although it does not top their list of concerns, about one-fifth of GLOBE teachers reported that they have faced major challenges in keeping their equipment secure from vandalism or other damage. Among our case study schools, several had suffered vandalism to their weather station. Most GLOBE schools are coping with this challenge by putting their weather site in a reasonably public place and building a fence or "dog kennel" around it. Another school reported developing a protective cover for the rain gauge; the cover was produced by the vocational education program's welding instructor.

Spreading GLOBE throughout a School. A challenge that was not asked about on the survey but that came up during site visits was going beyond a single classroom to get more students and teachers involved in GLOBE.

A teacher at another of our case study sites noted that spreading GLOBE beyond his own classroom had proved to be much harder than he had anticipated. Teachers have many demands on their time, and each wants to be recognized as making a distinctive contribution. At two of our case study sites, we were told that other teachers regarded GLOBE as the lead teacher's "thing." As such, it was something these other teachers were reluctant to adopt because they could only be "followers." A strategy for overcoming this barrier, developed by a GLOBE teacher at a magnet school for gifted students, is the "trade-a-lesson" plan. The GLOBE lead teacher offers to give GLOBE lessons to other teachers' students if the other teachers will provide his students with a lesson in their own specialty areas (see Exhibit 5.4). This approach gives more students exposure to GLOBE while recognizing the contributions that other teachers can make. Another approach is the spreading of GLOBE activities through cross-age tutoring projects. In addition to the educational benefits of one-on-one tutoring, such strategies are ways to involve additional classes in GLOBE, and at several case study schools they became the mechanism through which responsibility for certain GLOBE measurements passed from one class to another. A third strategy can be applied in settings where teachers work in multidisciplinary teams. Whereas one teacher may have primary responsibility for organizing GLOBE activities, others can be involved in developing lessons connected to GLOBE. At one junior high school, for example, the mathematics teacher developed statistics and graphing math lessons to go along with the GLOBE biometric data collection.

One teacher described how a whole school department was implementing GLOBE. Measurement responsibility was rotated across classes 1 week at a time. The lead teacher

Exhibit 5.4
Trade-a-Lesson Strategy

GLOBE Lessons

To: Manchester Teachers
From: Bob Jost

I have several GLOBE lessons that I would like to share with your classes during the closing weeks of this school year.

"Fresno From Space" - introduction to remote sensing and a chance to see what Manchester GATE School looks like from the Landsat satellite. We'll take a look at current weather satellite images and other remote sensing images on the Internet. We can also arrange a follow-up session in the MultiMedia Lab where your students can learn to use the MultiSpec image processing software and explore the Fresno Landsat image on their own.

"Introduction to the Internet" - this activity will introduce your class to the rapidly expanding world of the Internet. I can design the lesson to focus on a current topic that you are studying.

"Basic Biometric Instruments" - this is a "make-it, take-it" lessons where your students will construct a clinometer (used to measure the height of trees) and a tube-sight densiometer (used to measure canopy cover). We will then use the instruments to take biometric measurements of one of the pixels (smallest element of a Landsat satellite image) on the Manchester campus.

We can arrange a "class exchange" where you take my class for a full afternoon and share an art/math/science lesson or short lesson during the upper-grade PE time where you would merely supervise my class during PE. Let me know if you are interested... Bob Jost

laminated copies of the protocols from the GLOBE Web site to create a “data book” that could be passed to the responsible class.

Exhibit 5.5 contains a selection of additional strategies suggested by GLOBE teachers responding to the survey.

Exhibit 5.5
Samples of Teacher Strategies for Overcoming Implementation Challenges

Obstacle	***Strategy***
Involving more students and classes	Initial group of students trained by the GLOBE teacher developed “how to” guides for the GLOBE equipment, which they then used in training other students.
Getting administrator support	Students demonstrated GLOBE and their use of the computer to administrators and community members, eliciting very positive responses and support for the program.
Getting technical support	Called on technically skilled parents.
Obtaining funding for equipment	Funding for computers and equipment obtained through partnership grant submitted to local electric company.
Arranging transportation to off-campus study site	Teacher obtained a bus driver’s license.
Getting parent volunteers	Used a sign-up sheet at first parent-teacher conferences for week-long responsibility for GLOBE site transportation and measurements.
Involving whole class when only a few take each measurement	School data were posted on the wall, and the whole class examined and discussed the data at roughly 6-week intervals.

Assistance That Practicing GLOBE Teachers Would Like to Have

At the time the Teacher Survey was developed, a number of enhancements to GLOBE's support for teachers were either in the planning stages or under consideration. The survey invited teachers to rate these enhancements in terms of their value. Table 5.4 shows the proportion of teachers viewing each of these enhancements as "very valuable." Among the options provided, teachers anticipated getting the most value out of the provision of additional ideas for student investigations and analyses. Close behind were the presentation of integrating themes that cut across study areas and modularization of the Teacher's Guide.

Table 5.4
Potential Additional Supports Rated "Very Valuable" by Teachers Implementing GLOBE

Potential Support	*Percent of Trained Teachers*	*Percent of Active Data Providers*
Student investigation and analysis ideas	53	60
Integrating themes cutting across study areas	49	51
Modularized teacher guidebooks	49	48
Information on how to adapt GLOBE for my grade level	36	35
Guidance on how to implement GLOBE at the school level (multiple classrooms)	36	32
Statement of specific learning outcomes fostered by GLOBE activities	26	38
More information about GLOBE science investigators and their research	29	35

Sample sizes: Trained Teachers, $208 \leq n \leq 212$
Active Data Providers, $214 \leq n \leq 221$

In responding to this survey item, 154 teachers (from the two samples combined) availed themselves of the option to write in suggestions for additional support. Table 5.5 presents a classification of their write-in responses. The most frequent category of recommendation was for additional teacher training or mentoring. Some suggested refresher courses; others talked about mentor teachers or teacher networks. The second most common write-in category consisted of additional interaction with and feedback from the GLOBE program. As one teacher expressed it, "It would be very helpful to have a GLOBE representative visit our school to verify that we are taking measurements correctly or give us ideas for our particular situation. Also, a list of GLOBE scientists who are willing to come to schools to speak on particular topics would be nice." One teacher suggested reminders on the Web page when it is time to take certain measurements (e.g., biometrics). More specific feedback on the student data would be appreciated also ("Students need feedback as to what their data is 'doing'.") Help with Internet access and obtaining computers was mentioned by 22 teachers, and 21 asked for lesson plans or protocols aimed at specific grade levels. Eighteen teachers made specific recommendations for improvements, such as maps, the Teacher's Guide, or GLOBE Mail (would like an alert that they have mail). Finally, 13 said that they would like help in promoting GLOBE within their community or to their administration.

Table 5.5
Classification of Write-in Suggestions for Providing Better Support to GLOBE Teachers

Type of Support	*Number Suggesting*
Additional teacher training, mentoring	49
More feedback from, interaction with GLOBE office	40
Help improving Internet/computer access	22
Revised lesson plans/protocols for specific grade levels	21
Improvement of existing aids (e.g., GLOBE Mail, Teacher's Guide, visualizations)	18
Help with promoting GLOBE to other funders, school administrators	13

The teachers at our case study sites expressed similar ideas. These teachers, too, stressed the need for mechanisms for ongoing refresher training and teacher support. Among suggested mechanisms for achieving this result were creating electronic communities of GLOBE teachers, providing training resources on the GLOBE Web pages, and videoconferencing.

Case study teachers made a number of recommendations for revamping the Teacher's Guide. One teacher recommended breaking the Teacher's Guide into separate sections for elementary and secondary teachers and providing more examples and ideas suitable for primary students. Another teacher liked the way the Guide is organized but wanted the rationale for studying a topic to be presented with each protocol and to have more cross-referencing between conceptual material (e.g., dominant species concept) and the protocols.

Internet access time was an issue for several case study teachers. One teacher noted that the visualizations took a long time to download through their connections. Another suggested that GLOBE negotiate discounts with telecommunications carriers. Telecommunications rates were a major issue cited by several country coordinators, as well.

Overall, it appears that assistance with Internet connections and software is a major hurdle for many of those getting started with GLOBE and in countries with high rates for connect time and/or few telecommunications providers. Once the program is up and running, the main things teachers are looking for is ongoing support and interactions with GLOBE staff or mentor teachers and more feedback for their students. Another theme of teacher concern has to do with adapting the program for their classes: teachers want a clearer picture of what students can learn from the activities and assistance with adapting GLOBE for the grade levels they teach.

Chapter 6. GLOBE's Influences on Students and Teachers

Research on reform-oriented educational interventions and on technology-supported student-centered instruction tells us that an innovative program's full impact on teachers and students is not likely to be evident for 3 years or more (Sheingold & Hadley, 1990; Means & Olson, 1995). Hence, it could be argued that it is premature to try to answer the questions of what impact GLOBE has on students and teachers after a year or less of program implementation. In particular, we will place limited emphasis on the results of the pilot student assessment embedded in our surveys of 4th-, 7th-, and 10th-graders. Nevertheless, data on how the program has influenced students and teachers during its first year of operation will provide a baseline against which subsequent findings can be compared. In addition, "softer" data on teachers' and students' perceptions of the program's effects are important because they provide information about the way in which the program is perceived, with implications for rates of continued participation. First, we will review teachers' perceptions of GLOBE's effects on students and then discuss the reports of the students themselves. In a final section, we will present the evidence concerning the effects the program is having on the teaching style of participating teachers.

Teacher Reports of Impacts on Students

Teachers were asked to estimate the extent to which their students were interested in various components of the GLOBE program. The response patterns to these survey items were similar for the Trained Teacher sample and the Active Data Providers. We will present data from the latter teacher group here, on the assumption that those teachers who have implemented the program more thoroughly are in a better position to observe effects on students. (Both sets of data are presented in the Data Appendix to this report.) As shown in Table 6.1, teachers were extremely positive in their assessments of their students' interest levels. GLOBE activities in general were reported to be "very interesting" to their students by 79% of the Active Data Providers. Among the components of GLOBE about which teachers were questioned, using computers to work with GLOBE data and taking GLOBE measurements were perceived as the most popular activities (with 88% and 82% of teachers saying their students were "very interested" in these two aspects of GLOBE). International teachers surveyed, with their somewhat older students, were somewhat less likely to respond that their students were "very interested" in GLOBE (52% so responded). They perceived their students as most interested in using computers to enter GLOBE data (with 93% reporting that their students were "very interested"), followed by interest in communicating with other GLOBE classrooms (78%).

Table 6.1
U.S. Teacher Perceptions of Student Level of Interest in GLOBE

	Percent of Active Data Providers		
Aspect of GLOBE	***Very Interested***	***Somewhat Interested***	***Not at All Interested***
GLOBE activities in general	79	21	0
Using computers to work with GLOBE data	88	12	0
Taking GLOBE measurements	82	18	
Working with other students	57	38	5
Communicating with classrooms in other schools	51	38	12
Finding out about GLOBE scientists and their work	26	57	17

Sample sizes: 156 ≤ n ≤ 220

Beyond the perception of very high student interest in GLOBE activities, there is also the conviction among teachers that GLOBE is having a broader impact on student attitudes toward science and their relationship to this form of inquiry. Sixty-six percent of the U.S. Active Data Providers reported that GLOBE has improved the view of most of their students that they are capable of doing science. Sixty-five percent reported that most of their students now have a greater interest in taking science classes. Sixty-four percent judged that most of their students have an increased perception that science is a way to understand the world around them. Fifty-one percent reported that most GLOBE students have an increased interest in exploring scientific questions outside the classroom.

International teachers were more conservative in assessing GLOBE's influence on their students' attitudes toward science: 26% reported that GLOBE had improved the view of most of their students as being capable of doing science; 27% thought most had a greater interest in taking science classes; 36% felt that most of their students had an increased perception that science is a way to understand the world; and 39% saw a greater interest among most of their students in exploring scientific questions outside the classroom.

Teachers were asked also to reflect on what their students were learning from GLOBE. Table 6.2 displays the Active Data Providers' responses concerning the extent to which participation in GLOBE has increased student skills. Teachers hold a very positive view of GLOBE's impact on their students' skills. The biggest perceived impacts are in the areas of observational skills (72% reporting that GLOBE had improved skills "very much"), measurement skills (70% "very much"), and technology skills (68%). Roughly half of these teachers thought that GLOBE had very much improved students' abilities to understand data and to work in small groups. Smaller but still significant proportions reported major improvements in critical thinking (38%) and map skills (35%). One skill area not included on the survey but discussed during site visits was students' ability to regulate their own learning and performance. Teachers at four of five core case study sites reported that GLOBE had had a positive effect on these self-monitoring skills.

Table 6.2
U.S. Teacher Perceptions of How Much Student Skills Increased with GLOBE

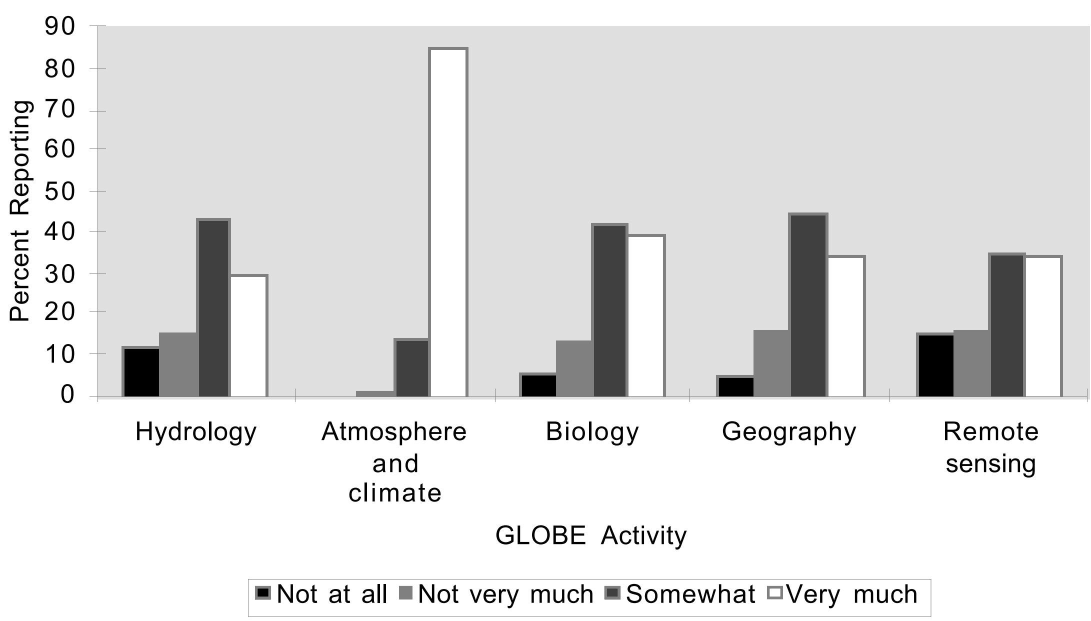
	Percent of Active Data Providers			
Skill Area	***Very Much***	***Somewhat***	***Not Very Much***	***Not at All***
Observational skills	72	28	1	0
Measurement skills	70	29	1	0
Technology skills	68	28	4	1
Ability to understand data	51	41	7	1
Ability to work in small groups	50	42	7	1
Critical-thinking skills	38	49	10	3
Map skills	35	38	18	9
English language skills	15	43	27	15

Sample sizes: $195 \le n \le 224$

Again, international teachers provided more conservative, but still quite positive, estimates. The biggest area in which they perceived a positive influence of GLOBE on student skills was in the ability to work in small groups: 48% reported that GLOBE had "very much" improved their students' skills. Similarly positive reports were provided for measurement skills (46%) and observational skills (44%). Among these international teachers, 33% reported that GLOBE had very much improved their students' English language skills.

Similar survey items probed for teachers' perceptions of students' increase in knowledge of various GLOBE study areas. The largest perceived gain in knowledge by far was in the area of atmosphere and climate, with 85% of the Active Data Providers reporting that their students' knowledge had increased "very much." (It should be noted that this is the area in which GLOBE schools are performing the most measurements.) For the areas of hydrology, biology, geography, and remote sensing, the corresponding percentages ranged from 30% to 39%. Figure 6.1 displays these data. International teachers surveyed saw the greatest knowledge increases in the area of atmosphere and climate, as well, with 56% reporting that student knowledge had increased "very much" in this area.

Figure 6.1. U.S. Teachers' Perception of How Much GLOBE Activities Have Increased Students' Knowledge



Sample sizes: 186 ≤ n ≤ 221

Case study teachers cited value also in the interchanges their students had with peers around the world. Although only a minority of GLOBE classes used GLOBEMail and many expressed frustration over unanswered messages, those who persisted started to develop exchanges that went beyond initial "pen pal" introductions. Exhibit 6.1 shows several examples from a junior high school in our case study sample.

What Students Like about GLOBE

Teacher reports of what students like about GLOBE can be compared with the reports provided by the students themselves. Table 6.3 shows the proportion of students in each grade-level sample reporting that they liked an aspect of GLOBE "a lot." As their teachers suggested, putting GLOBE data on the computer was the most popular of the activities we asked about, with 81% of 4th-graders, 58% of 7th-graders, and 56% of 10th-graders reporting that they liked it "a lot." Looking at satellite pictures (73%, 57%, and 55%) and taking measurements (70%, 52%, and 46%) were not far behind. Examining GLOBE data collected by students in other places was something that 56% of 4th-graders, 27% of 7th-graders, and 35% of 10th-graders said that they liked "a lot."

Students were asked to respond also to a broad set of attitudinal statements concerning GLOBE. Fourth-graders marked each statement as "true" or "false"; 7th- and 10th-graders rated a similar set of statements on a five-point scale from "strongly agree" to "strongly disagree." Tables 6.4 and 6.5 present the responses for the three grade levels.

These data corroborate the indications of highly positive attitudes toward GLOBE in the item about what students like, discussed earlier. If we treat "strongly agree" or "agree" responses on the part of 7th- and 10th-graders as the equivalent of 4th-graders' marking "true," we have 94% of 4th-graders, and 74% of 7th- and 10th-graders who say they like doing GLOBE activities in general.

Working with other students and using computers are two features of GLOBE about which the large majority of students are enthusiastic. Working with other students was rated positively by 88% of 4th-graders, and by 77% of 7th- and 10th-graders. The percentages endorsing computer use as a desirable feature were 97% of 4th-graders, and 77% of 7th- and 10th-graders.

Exhibit 6.1
Examples of GLOBEMail Communications

GLOBEMail For Belton Junior High School

From School : Mountain View School, Ontario, CA, US

Subject : RE:Ground level Ozone

To : 4TH PERIOD 8TH GRADERS

From :4TH GRADERS

Hello to all of you Texans,

We received your message just last week because our Internet connection was down for 7 days. Sorry you have had to wait so long for a reply. Your questions are interesting, but as 4th graders we have no clue about ozone alerts. Our air quality is monitored by the South Coast Air Quality Management District. They have a new office located only 15 miles from our school. We found them on the WWW and have contacted their Education Laison person. We have sent them your message and are hoping for an answer that is scientifically based.

We do have smog alerts several times a year - particularly in the summer and fall. We didn't know they came from "gound level ozone." To be truthful, we don't even know what that is. Can you explain that in terms 4th graders can understand? When we have smog alerts, they come in different stages. When it is a serious smog alert, we are not allowed to take jump ropes or other equipment to recess. In fact, we are not allowed to run. We do know smog is especially hazardous to children and the elderly.

We will get back to you as soon as we hear from the SCAQMD. Thanks for waiting.

Sincerely,
The 31 GLOBE students in Room 7
and their teacher, Mrs. Carteen,
at Mountain View School

Exhibit 6.1
Examples of GLOBEMail Communications (Concluded)

GLOBE MAIL **GLOBEMail For Belton Junior High School**

From School : Tonosho Junior High School, Kagawa, JP, JP

Subject : Please Send Me Latter

To : Ms.Connie Wood

From :Mr.Kengo Kouzai

How do you do?
I am Kengo Kouzai,a student at Tonosho Junior High School in Japan.
This year we have a severe winter.
We had a record snow in Japan.
I heard you have severe cold in the U.S. on TV.
Will you tell me some concrete instances about the cold?

REPLY DELETE

NOAA/Forecast Systems Laboratory, Boulder,Colorado

Table 6.3
Extent to Which Students Like Various Aspects of GLOBE

	4th-Graders			*7th-Graders*			*10th-Graders*		
Aspect of GLOBE	***Like a Lot***	***Like a Little***	***Do Not Like***	***Like a Lot***	***Like a Little***	***Do Not Like***	***Like a Lot***	***Like a Little***	***Do Not Like***
Putting GLOBE data on computer	81	15	4	58	33	10	56	27	17
Looking at satellite pictures	73	24	3	57	27	16	55	33	12
Taking measurements	70	25	5	52	41	7	46	41	13
Looking at GLOBE data collected by students in other places	56	38	7	27	51	22	35	41	23
Talking about weather, the earth, and water	55	42	3	29	63	9	34	56	10

Sample sizes: 4th grade, $499 \leq n \leq 758$
7th grade, $138 \leq n \leq 223$
10th grade, $82 \leq n \leq 107$

Table 6.4
Fourth-Graders' Attitudes toward GLOBE

Statement Regarding GLOBE	***Percent Responding "True"***
I like doing GLOBE activities.	94
Working with other students makes GLOBE more fun.	88
GLOBE has taught me how to do more things with computers.	71
It gets boring taking the same measurements over and over.	33
I think the GLOBE project will help people understand the earth better.	93
I don't know why we take the measurements we do for GLOBE.	16
The measurements my class takes are important for scientists.	93
What happens in one place on earth can make changes happen in other places.	87
I like to study science.	83
Scientists mostly just read books.	9
Lots of times, you need math to do science.	90
What we learn from science can help make our world a better place.	94
I might want to be a scientist when I grow up.	41
I like to use computers.	97

Sample sizes: $594 \leq n \leq 739$

Table 6.5.
Seventh- and 10th-Graders' Attitudes toward GLOBE
(Percent)

Statement Regarding GLOBE	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
I like doing GLOBE activities.	32	42	20	2	4
Working with other students makes GLOBE more fun.	46	31	17	4	2
GLOBE has taught me how to do more things with computers.	22	26	29	14	9
It gets boring taking the same measurements over and over.	19	18	29	19	15
I think the GLOBE project will help people understand the earth better.	34	39	21	2	4
I don't know why we take the measurements we do for GLOBE.	5	8	20	30	37
The measurements my class takes are important for scientists.	34	32	25	6	3
What happens in one place on earth can make changes happen in other places.	38	35	21	4	2
After doing GLOBE, I am more interested in taking science classes.	17	26	37	11	9
Scientists mostly just read books.	3	7	19	25	46
Lots of times, you need math to do science.	48	36	11	3	2
What we learn from science can help make our world a better place.	46	35	14	2	3
I might want to be a scientist when I grow up.	10	15	24	20	31
I like to use computers.	54	23	14	4	5

Sample sizes: $347 \leq n \leq 354$

In addition, students have a sense that the project is important. Ninety-three percent of 4th-graders, 72% of 7th-graders, and 75% of 10th-graders say that they think the GLOBE project will help people better understand the earth. Most students feel that the measurements they take are important for scientists (93%, 61%, and 76%, respectively). As one 6th-grader at a case study site put it, "I feel like we proved what we can do...that we're real scientists." Only small proportions of students reported that they do not know why they are taking the measurements they do (16%, 12%, and 16%). Somewhat larger groups, however, reported that repeatedly taking the same measures gets boring (33%, 41%, and 31%), an issue that should be considered in the development of future educational activities linked to the measurement protocols.

In terms of students' understanding and attitudes toward science more broadly, the student survey results were encouraging. A strong majority (83%) of 4th-graders said that they like to study science; 40% of 7th-graders and 46% of 10th-graders said that they are more interested in taking science classes after participating in GLOBE. There was strong agreement that what is learned from science can help make the world a better place (94%, 78%, and 86%) and an appreciation of the fact that mathematics is frequently involved in doing science (90%, 96%, and 81%). The earth systems concept that what happens in one part of the world can produce changes in other locations was strongly endorsed (87%, 74%, and 69%).

What Students Learn: Preliminary Findings from Student Assessments

The items embedded within the student surveys for the elementary and middle/ secondary levels were designed to measure students' understanding of three broad areas addressed in the first phase of the GLOBE program: (1) taking accurate measurements, (2) using sound measurement procedures to ensure data quality, and (3) analyzing and interpreting GLOBE-related concepts and data. Three parallel forms were developed by randomly assigning items for each area to a form. Different items were seen by differing numbers of students. Students could mark that they had not yet studied the information queried in an item. These preliminary analyses of student performance, then, are based only on those students who attempted the items. Technical item analyses are currently under way to confirm the technical quality of the pilot items and inform further development of the item pool. Below we summarize student performance on the pools of items developed to measure the three learning areas.

Taking GLOBE Measurements. Most items in this pool presented graphical representations of instruments used in GLOBE protocols to measure air temperature, precipitation, canopy cover, and cloud type. Students were asked to select the correct instrument reading or data report.[7] In general, the data indicate that most students have the knowledge needed to make accurate GLOBE measurements. Students made precipitation level readings with ease, averaging 97% correct for both 4th-grade and older students. Air temperature readings for maximum, minimum, and current temperatures averaged 64% correct for elementary students and 75% for middle and secondary students. Students were also quite successful at reading canopy cover measures (67% correct). Students were less able to identify the types of clouds presented, however. Performance levels ranged from 28% to 56% correct, depending on the grade level and type of cloud presented, with an average across items of 36% correct for 4th-graders and 44% for older students.

Using Sound Measurement Procedures. These items presented situations requiring students to identify a procedure for ensuring data quality. Problems included identifying a way to resolve discrepant measurements or identifying the best procedure for conducting a measurement or calibrating an instrument. Numbers of 4th-graders attempting these items ranged from 240 to 485 students. These young students demonstrated an impressive grasp of measurement concepts, although there is ample room for improvement. An average of 58% of the 4th-graders answering items on data quality did so correctly (ranging from 49% to 65% across the various items).

The secondary students received more and more challenging items. The average percentage correct for such items on the older students' survey was 43%.[8]

Analyzing and Interpreting GLOBE Data and Concepts. This cluster of items addresses the question of whether students can apply earth science concepts related to the GLOBE investigations. Items in this pool ask students to analyze and interpret graphs and charts of GLOBE data or to identify appropriate explanations and conclusions based on GLOBE-related concepts. Among the 4th-grade sample, the average percentage correct on such items was 58% (with a range from 43% to 69% across the various items).[9] Among middle and secondary students who attempted a broader and more

---

[7] The frequency of 4th-grade responses to these items ranged from 337 to 716 students. Response frequencies per item on the 7th- and 10th-grade form were from 161 to 310 students.
[8] Only 54 students attempted the item concerning soil moisture readings; other items were attempted by between 212 and 233 middle and secondary students.
[9] From 250 to 445 elementary students attempted these items.

difficult set of items falling within this category, the average percentage correct was 66%.[10] The range of correct responses for these items was from 21% to 85%, with the low value occurring for an item on assessing the reasonableness of soil moisture readings.

Interpretations of First-Year Student Assessment Preliminary Findings. These preliminary student achievement results provide tentative but encouraging evidence of the GLOBE program's influence on student learning. Students seem to be making substantial progress in acquiring measurement skills and learning related science methods concepts. Although this early evidence is heartening, we suggest that it be considered with caution. Like the GLOBE program itself, the student assessment component is in the pilot phase. The student assessment items, for the most part, are taken or adapted from existing measures, but nearly all have been modified and some are newly created. Items will be analyzed for technical quality. In addition, further work remains to expand the pilot pool of items to both increase coverage of first-year material and add items for new, Phase 2 modules. Finally, student skills and knowledge need to be measured at the outset of their involvement with GLOBE and after significant GLOBE experience so that we can examine the magnitude and locus of performance improvements.

Observations of Students in GLOBE Classrooms

Our other major source of information about what students are learning from GLOBE lies in observations of student behavior during visits to the case study sites. In a number of classrooms, we were struck by the students' commitment to collecting and reporting accurate data. In addition to being highly motivated in this regard, students we observed demonstrated the use of procedures for checking the reasonableness of their data and for obtaining more accurate data through taking multiple measurements and averaging. Exhibit 6.2 contains a description of one such activity from a 6th-grade class.

On the negative side, there were cases where the site visitors questioned students about the meaning of the measures they were taking and found limited ability to explain or make inferences based on instrument readings. Some students showed confusion, for example, about the meaning of the soil moisture meter readings, the impact of altitude on air temperature, and the relationship between Fahrenheit and Celsius measurements.

[10] Only 86 students attempted the soil moisture item (with most students declining to answer because they had not done activities in this area). Other concept items were attempted by between 173 and 350 middle and secondary students.

Exhibit 6.2
Reasoning about Data Accuracy and Precision

A major thrust within this 6th-grade classroom is the teaching and learning of concepts of data reliability and accuracy. The fall and spring collections of GLOBE biometric data provided a context for instruction in these areas. Ten small groups each measured the height and diameter of a specified tree and independently took measures of the canopy and ground cover. The measurements were brought back into the classroom for review and discussion.

The tree measurements were dealt with as an extension of prior measurements. In October, the students had compared the data collected that month with the measurements taken in April 1995 and pursued a number of questions concerning how trees grow. The data collected in April 1996 were compared with the October and April 1995 data. The rates of change in the two time intervals were compared. Reasons why trees might grow more from April to October than from October to April were discussed. The class also compared growth estimates based on tree height with those based on diameter. A number of trees that appeared to "shrink" on the basis of the height estimates showed growth in terms of diameter. The teacher suggested that the latter appeared to be a more reliable measure of growth.

The 10 independent ground cover and canopy measures were all projected on a screen in front of the class to permit scrutiny and averaging before determining the measures to report to GLOBE. The students were clearly highly motivated to produce accurate data and engaged in lively discussions comparing the readings obtained by different individuals or groups and assessing the acceptability of a given measurement. One student group had a ground cover estimate much lower than those of the other groups. The class noted the discrepancy and asked about the procedure used to take the measurement. On finding that it did not match the protocol precisely, they decided that the measurement should be removed before the group readings were averaged

The next day, a student from this same class applied a similar critical stance to reviewing the data provided by others. While looking at GLOBE biometric data from the archive, he noticed that one school had reported a tree over 70 meters high. The student pointed out this entry in the GLOBE database, "A tree over 200 feet high in Massachusetts? I don't think so!" The student went on to discuss the entry with several peers. They reasoned that only a redwood could be that high, and redwoods don't grow in the eastern United States. The students pointed out the anomaly to their teacher, who suggested they e-mail the school that had made the measurement.

Although our probing of students was done opportunistically and involved few students, it does suggest that there should be vigilance about connecting the GLOBE measurement protocols to educational activities that elucidate the significance of the data and the reasons for various aspects of the prescribed procedure. We believe that it is important to note that when GLOBE teachers at the case study sites were probed about seven areas in which GLOBE might have affected their students, the area in which they were least likely to note effects was "data interpretation, analysis, and representation," noting in a number of cases that they "have done little with that so far."

GLOBE's Influence on Teachers: What and How They Teach

Although GLOBE does not prescribe either a curriculum or specific teaching practices, its project orientation is highly compatible with pedagogical concepts being advocated in many education reforms. By design, it engages students in authentic tasks, which are amenable to small-group work, student-centered instruction, and interdisciplinary efforts. Although influencing teaching practices was not one of the explicit goals of the GLOBE program, we examined our data for potential side effects in this area. Rather than asking the teachers to describe their instructional practices (a strategy that runs up against teachers' knowledge of the current teaching "fashions" and their desire to present themselves in a favorable light), we asked students to compare their experiences in GLOBE with other school activities. Fourth-graders were asked to compare their activities during GLOBE with times when their class worked on other projects or subjects; older students were asked to compare GLOBE with other science class activities.

Contrary to our expectations, students did not report that they do more group work with other students, writing about what they have learned, helping other students, or problem solving when doing GLOBE. These survey findings from broad samples of GLOBE students stand in contrast to the activities we observed in our case study schools. Three of the five case study sites, for example, had active cross-age tutoring programs around GLOBE. Where teachers have made the effort to plan activities, GLOBE is clearly conducive to cross-age tutoring, collaborative learning, and the development of related writing assignments. Exhibit 6.3 contains an example of collaborative learning and multi-age activities. Exhibit 6.4 displays three pieces of GLOBE-related student writing. Of course, it is possible that comparisons between different parts of their school day are difficult for students to make or that reform-oriented classroom activities are broadly present not only in GLOBE but also in other science classes or in elementary school generally. In the case of one of our case study sites, for example, the teacher did a great deal of collaborative learning, cross-age tutoring, and writing assignments connected with GLOBE, but these features were characteristic of his teaching in general. In a focus group discussion, the students told us that the teacher did not teach differently but that he was "more energetic" when doing GLOBE. The lack of differences favoring GLOBE in our survey data on such instructional practices suggests that GLOBE cannot be credited, at least at this stage, with any major reform-oriented influence on teaching.

Differences that students did cite between GLOBE and non-GLOBE school activities were:

- Less boredom
- Less answering of questions from a book or worksheet
- Less confusion about what they are supposed to be doing when involved in GLOBE.

These results make sense in light of students' obvious interest in GLOBE, the lack of worksheets connected with the program, and the emphasis on careful adherence to data collection procedures. Fourth-graders, but not older students, reported greater use of a computer and more involvement with something they consider important when engaged in GLOBE activities.

Exhibit 6.3
Examples of Collaborative Learning and Cross-Age Tutoring at GLOBE Schools

Sixth-graders at this elementary school have been collecting GLOBE data since Earth Day 1995. During the 1995-96 school year, they began involving 4th-graders from another class in taking the daily atmospheric measurements. Typically, a group of three 6th-graders pick up several 4th-graders and take them to the weather station where the team makes the measurements. All students must agree on a value before it is recorded.

On the day of our observation, these same two classes were teamed up to do the spring biometric measurements. Sixth-graders made clinometers and tube sights for their 4th-grade colleagues on the day preceding the measurements. On the observation day, groups of three 6th-graders teamed up with a like number of 4th-graders. Each group had a tree for which they measured circumference (and calculated diameter) and estimated tree height. Each group also measured both canopy cover and ground cover along one or both of the pixel's diagonals. The 6th-graders explained the measurement procedures to the 4th-graders. The 6th-graders were careful to give the younger students the chance to take the measurements themselves, but acted as the final arbiter of which readings to record and which to repeat. Separate discussions of the measurements were held in the two classes, but the 4th-grade teacher did use graphs that 6th-graders had produced comparing their spring measurements with those of the preceding fall and spring.

Exhibit 6.4
Students' Writing about GLOBE Activities

April 25,1996

Principles of Global Change as Evidenced by the G.L.O.B.E biometric site at Manchester G.A.T.E. School

The meaning of the words Global change means, when the earth around us Changes. Also the term Global warming means the heating of the earts atmos-phere. I learned this in class when we were learning global Changing. The class got together and talked about the varied growth rate of trees. The ways that the class came up with were: spec-ies, maturity, space, location, soil, Sea-Son, rainfall, polution, climate, and pests.

In the maturity of the trees they go through three sta-ges. The stages are saplings, mature, and cliamax. When they are saplings they grow real fast. When they are in the

Exhibit 6.4
Students' Writing about GLOBE Activities (Continued)

mature stage the grow steadly. Finally when they are in the cliamax stage they either grow slowly or stop.

For the space and soil, they need minerals and water. Also they can't be overcrow-ding or shaded too moch.

Season has a lot to do with it. Trees have a tendacy to grow more durring the summer. Also if the tree is dicidious or evergreen matters a lot.

Height	May-Oct	Oct-April
Bottle Brosh:	15%	6%
Chinese Pistachio:	14%	8%
Canary Island Pine:	8.7%	2%
aurage	14%	5.3%

Diamiter	may-oct	oct-April
B.B.:	4%	1.6%
C.P.:	14%	7.75%
C.I.P.:	8.7%	4.8%
aurage	9.4%	5%

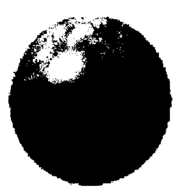
Exhibit 6.4
Students' Writing about GLOBE Activities (Continued)

If you want to see something
two centimeters tall
Walk out Ms. Wood's door and
down the hall.
Go down the sidewalk and
over to the thermomiter
that looks like a birdfeeder
walk across the grass about
a meter and that's my place
It's where the grasshoppers
hop happly and the catapillars
roam free and the ants
play activly.
There maybe only fourteen
hours of sunlight but to
them it's always bright.
When it rains you may see
the ants with a frown with
the fear they may drowned.

Exhibit 6.4
Students' Writing about GLOBE Activities (Concluded)

KINKAID'S BACKYARD

Through the front gates, past the school buildings, and all the way behind the sports fields is a little plot of land, only three point four acres, that rests on the banks of Buffalo Bayou. Kinkaid has a place that is both natural and beautiful, where children as well as teachers go for inspiration and knowledge. This land, which was once used as a dump by the school, is perhaps one of the last natural areas remaining on Houston's bayou. Now the dump has been cleared, the beat up Mercedes, the old rusty sinks, the bits and pieces of tires, and the broken pipes and cables have all been dragged out, and in their place lives a very small and fragile ecosystem that we call the Kinkaid Backyard, a beautiful plot of land that brings artistic inspiration and peace of mind to all who enter it.



Chapter 7. Conclusion: Toward Refining the GLOBE Program

In this final chapter, we seek to provide some perspective on our data, summarizing both the main strengths of the program's first year of operation and areas where refinements could improve its educational effectiveness.

Program Strengths

Although GLOBE has many engaging aspects, the evaluation team was most impressed with four key features:

- Extremely high student and teacher enthusiasm
- Flexibility, making it adaptable to a broad range of settings and students
- Model for instructional use of Internet connection and resources
- Stimulus for collaborative learning and cross-age activities.

Each of these will be discussed briefly.

Extremely high student and teacher enthusiasm. The enthusiasm that new GLOBE teachers demonstrate at the conclusion of their training workshop tends to be challenged later by the travails of implementation at their respective schools. Nevertheless, most teachers remain strong advocates for the program. Commitment to the program's approach and a willingness to figure out how to surmount the inevitable implementation problems characterize the teachers implementing GLOBE. As one teacher wrote:

> *I've found that computer problems are solved easily by asking knowledgeable parents. Scientific questions, questions about interpreting data can be solved by email and telephone calls to experts. Part of the strength of the program is to work through some of the questions with students. . . this is real critical thinking. . . solving authentic problems with the students has been a strength.*

A major source of GLOBE teachers' continued enthusiasm has been their students' response to the program. On our survey, 73% of trained teachers who have implemented the program with students described their students as "very interested" in GLOBE.

Students in classes actively providing GLOBE data are similarly enthusiastic. Comments written on their surveys included:

> *I THINK THE GLOBE PROGRAM IS GREAT. I ENJOY SCIENCE MUCH MORE. THANKS AND KEEP IT GOING!!!*
>
> *GLOBE is cool!*
>
> *I think the globe program is neat and all of my friends do to [sic]. Globe teaches kids to learn things like how to measure water.*

Although we must be cautious about overinterpreting the student reports from a sample that may not be representative, the students in active GLOBE classes clearly view GLOBE activities as both interesting and important. Site visitors heard 9th-graders in a class for low achievers describe how they enjoy GLOBE because it challenges them to think. Elementary school students gravely explained the importance of their data. Nor were these empty claims. We observed examples of classes where the data quality procedures in place were of a sort one rarely sees in any science class below the college level.

Flexible program, adaptable to a broad range of settings and students. GLOBE was designed for the broadest possible use, and it appears to be making strides toward achieving that goal. More than 80,000 U.S. students are participating and range from the gifted to the non-college-bound and from kindergartners to high school seniors in public schools, private schools, alternative schools, Advanced Placement classes, schools for girls, tribal schools, a residential youth program, and a school for the blind. Because of the way GLOBE is structured around a set of data collection protocols rather than specific educational activities, it affords a wide range of implementation strategies. At the same time, by starting with genuine scientific activities, the program exemplifies the multidisciplinary nature of earth science and can be connected to many different academic subjects.

Model for instructional use of Internet connection and resources. Although Internet access remains an issue for many classrooms, school networking is booming. Between 1994 and 1995, the proportion of U.S. schools with access to the Internet grew from 35% to 50%. Many schools are finding themselves with a new Internet connection and a paucity of ideas about ways to use it beyond the search for information resources. In other cases, teachers who would like to obtain Internet access need to respond to administrators or potential funders who say “for what purpose?” For many schools, GLOBE has met these needs. As one survey respondent expressed it:

> *It [GLOBE] has provided a vehicle to get the Internet computer technology into my classroom. I have the only 'on-line' computer in the school. I have run several in-services for teachers regarding this [technology]. Students from language classes, social studies classes and business classes have all used the computer's Internet capabilities. My classroom is one of the most popular and busiest in the school.*

Conducive to collaborative learning and cross-age activities. GLOBE measurement activities are most easily done in small groups. Likewise, data quality techniques stress the importance of comparing independent measurements, identifying unreasonable data, and resolving discrepancies. Through such collaborations, students can learn from each other, as well as provide more and better data than could be expected from a single individual. Typically, GLOBE schools began by trying out activities with a single grade level, but many have begun moving toward having students teach other students at a different grade level. The students providing the training profit from having to learn the procedures well enough to be able to demonstrate and explain them. Moreover, students enjoy the experience of being the source of knowledge for a change. Because GLOBE activities are quite amenable to training and don't require the years of practice that go into something like learning to read or mastering cursive writing, both the students being trained and those doing the training can quickly see the fruits of their labor.

Emerging Issues

Although the problem of obtaining adequate Internet access appeared to be the largest barrier to teachers' getting the program started after going through GLOBE training, we believe that the GLOBE program has been well aware of this difficulty and has addressed it vigorously through both financial and technical support for network connections. Our recommendations will focus instead on the issues we saw in the programs that were up and running and that were actively providing measurements for the GLOBE database. Principal among them were:

- Requirement for significant amounts of teacher time, motivation, and persistence
- Need for mechanisms for ongoing teacher support
- Limited use of some GLOBE capabilities and investigations
- Desire for guidance on keeping the whole class involved with GLOBE
- Need to prevent divorcing of data collection from conceptual learning
- Challenge of spreading GLOBE throughout a school.

Requirement for significant amounts of teacher time, motivation, and persistence. In one way or another, the chief concerns of the teachers whose students are actively collecting and submitting GLOBE data all have to do with time. Getting measurements taken over weekends and vacations was the most often cited concern, and when other mechanisms were not in place or fell through, many GLOBE teachers found themselves left to fill the gap. At the same time, teachers struggled with finding the time necessary to set up GLOBE activities and to prepare themselves to conduct them. Trying to fit GLOBE into existing curricula was another time-consuming demand, as was getting network connections and software up and running. School administrators at our case study sites almost invariably stated that their school's GLOBE program would not be possible without the extreme dedication and perseverance of the GLOBE lead teacher. As one survey respondent put it:

> *One must simply have an abundance of energy and motivation to continue to carry out GLOBE's activities considering the time and curricular constraints.*

Geoffrey Moore (1991) has developed a model of technology acceptance. In Moore's terminology, GLOBE teachers are "early adopters" who see the benefits of the program and are willing to tolerate significant inconvenience because of those benefits. Moore states that the primary challenge for new technologies is "crossing the chasm" between this small group and the much larger "early majority" who are favorably inclined but very pragmatic about the time they must invest.

In its first year, we have seen that GLOBE can be a wonderful program in the hands of dedicated innovators, but its growth will depend on making it easier to implement so that a larger group of teachers will feel comfortable taking on the responsibility and will execute the program well.

Need for mechanisms for ongoing teacher support. GLOBE teachers recognize that the program is quite complex, and, as intensive as their initial training is, it can not cover every contingency or provide enough practice to guarantee that all procedures are learned thoroughly. GLOBE teachers feel a need to remain connected to the program, particularly to other teachers in the program, after returning to their individual schools.

The severity of this need is heightened by the flexibility that is one of the program's strengths. Given minimal structure, teachers can adapt the program to their students' needs and their local curriculum, but they are also free to distort or degrade its message. We do not advocate taking away the program's reliance on individual teachers' skills and creativity; rather, we advocate providing additional resources and feedback to allow teachers to get input regarding the quality of their practice and to reflect on and refine the way they are implementing GLOBE.

In addition, the program is constantly evolving. As protocols are amended, and particularly as the new protocols and educational activities come on-line in Phase II, there will be great need for refresher training. We recommend consideration of the development of training videos for each GLOBE investigation, which teachers could use to refresh their memories or as supports in training others. We endorse also careful consideration of the recommendations of teachers in our survey and case studies: annual training conferences; regional, subject specialty, and/or grade-level list servers for GLOBE teachers; greater use of the Web site as a medium for training; local refresher training sessions; and the use of GLOBE "mentor teachers" who can make site visits to offer guidance, feedback, and model lessons. Although the GLOBE program's options are restricted by funding limitations, movements toward the "franchise" training model should provide a mechanism for trying out and evaluating options such as annual local training conferences or roving mentor teachers in different localities.

Limited use of some GLOBE capabilities and investigations. The area in which GLOBE teachers were most likely to report feeling inadequate was in use of the MultiSpec software. Many had trouble getting the software to run on their own computers. Others appeared unclear about how they were supposed to be using the software with students. Overall, 61% of U.S. trained teachers said that none of their students used the software in a typical week.

Although technical skill is less of an issue with the data visualizations provided on the GLOBE Web site, the same issue of lack of training on educationally worthwhile uses of the resource applies. In both cases, a mismatch between the software development cycle and the training schedule was largely responsible for the ensuing difficulties. Nevertheless, these areas should get much more attention in future training and teachers' guides. Finally, some investigations, most notably soil moisture, had a low implementation rate. We believe that failure to adopt this protocol reflects the complexity of the prescribed preparations. This finding has implications for the development and implementation of future GLOBE data collection protocols.

Desire for guidance on keeping an entire class involved with GLOBE. Teachers continue to grapple with the challenge of involving all their students in GLOBE when the data collections are most efficiently done by just a few students. Site visits and phone interviews confirm that at some schools, only a few students take measurements and others have limited contact with the program. Although this arrangement may be acceptable, and perhaps even desirable, from the standpoint of data collection, it is a weakness from the standpoint of GLOBE's educational goals. Some teachers stick with small teams of data gatherers but have instituted a system for rotating responsibility through a classroom. For those measurements that are taken less frequently, some teachers are having multiple groups take the same measurements and incorporating the different sets of measures into lessons on averaging and data accuracy and precision. In general, to the extent that data interpretation and analysis activities are built around the data, there will be increased opportunities for larger groups of students to be actively engaged. The revised Teacher's Guide will provide many ideas for educational activities. Further program refinements might include the development and dissemination of model lessons, which should include tips for classroom management as well as descriptions of educational activities.

Need to prevent divorcing of data collection from conceptual learning. A related but more general concern is the extent to which schools judge the success of their GLOBE program solely in terms of the number of pieces of data they have submitted to the archive. Although this is one success criterion (and one that is reinforced by the GLOBE Stars page), it certainly is not the only one, and programs need to guard against divorcing the collection and transmission of measurements from the scientific questions and educational context that should surround them. GLOBE can help to address this imbalance in several ways. By providing GLOBE teachers with statements of the learning objectives associated with each investigation, for example, GLOBE can support development of crosswalks between these objectives and states' science frameworks. Another useful support would be model classroom assessment tools to help teachers gauge whether their students are learning the concepts related to the investigations. The second edition of the Teacher's Guide will provide learning objectives for each investigation and some suggested assessment activities, but the latter are not fully developed models. We recommend consideration of the development of some sample performance assessments that teachers can administer within their classrooms.

Challenge of spreading GLOBE throughout a school. This challenge can be especially difficult in schools with departmental structures and short instructional periods. As GLOBE moves into a new phase of teacher training, more attention should be given to this issue. Assuming that the GLOBE program continues to grow and that the demand for GLOBE training increases, it may be possible to place additional requirements on schools wishing to join the program. Many educational innovations have had good success (Office of Technology Assessment, 1995) with a model in which more than one teacher, and often the principal, are required to attend training in order to ensure broader support for the program within the school and to provide the teacher with knowledgeable colleagues on return to the school site.

The GLOBE program has made impressive progress in its first year, developing a set of measurement protocols, assembling an initial set of learning activities, establishing an extensive support infrastructure, and implementing a broad-scale teacher training program. Although not all portions of the program have been implemented fully in GLOBE schools, enthusiasm and support for the program remain high among those teachers who have implemented some part of it. Just as important, the program is giving students a new perspective on what it means to do science and to be part of a scientific investigation. GLOBE's combination of hands-on activity, use of technology, and involvement in real research projects not only has wide appeal for students but also provides them with a deep sense of the value of their activities. In its second year, the program will expand its range of investigations and refine Phase I protocols to reduce opportunities for the introduction of error. By also addressing the challenges discussed above, the program can demonstrate the compatibility of good science and good education.

References

Gore, A. (1992). *Earth in the balance: Ecology and the human spirit.* New York, NY: Houghton Mifflin.

Means, B., and Olson, K. (1995). *Technology's role in education reform.* Menlo Park, CA: SRI International.

Moore, G. A. (1991). *Crossing the chasm: Marketing and selling technology products to mainstream customers*. New York: Harper Business.

Office of Technology Assessment. (1995). *Teachers and technology: Making the connection*. Washington, DC: Government Printing Office.

Sheingold, K., and Hadley, M. (1990). *Accomplished teachers: Integrating computers into classroom practice*. New York: Center for Technology in Education.

APPENDIX:

Teacher and Student Surveys

OMB No. 0648-0310
Approval Expires: May 31, 1996

A SURVEY OF TEACHERS PARTICIPATING IN THE GLOBE PROGRAM

The public reporting burden for this collection of information is estimated to average 5 minutes for Part I and 20 minutes for Part II per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to The GLOBE Program, 744 Jackson Place, Washington, D.C. 20503.

The information provided by respondents in this survey will be used to prepare summaries in aggregate form that do not identify individual respondents. The identity of respondents will be assured to the extent provided by law, including the Freedom of Information Act. Reasonable steps will be taken in the processing and analysis of respondent data to attempt to avoid any unintentional dissemination of information in which respondents and/or their responses may be identified.

Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirement of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB control number.

GLOBE Teacher Survey

Name: ___________________________________

Today's Date___________ (month/day/year)

School Code: ___________________________

PART I

1.1 Have you been implementing GLOBE activities with students?

☐ Yes

Please answer the question in this box and then skip to Part II of the survey.

Do you have access to the World Wide Web?

☐ Yes — Please access http://helpnet.sri.com/globe/TeacherSurvey.html and complete Part II of the Teacher Survey on Line.

☐ No — Please skip to Part II of this survey and complete it on hard copy.

☐ No — *Please continue with question 1.2*

1.2 What barriers have kept you from implementing GLOBE with students?

		Not a barrier	Minor barrier	Major barrier
a.	Lack of phone line.	☐	☐	☐
b.	Lack of Internet access.	☐	☐	☐
c.	Lack of computer hardware/software.	☐	☐	☐
d.	Lack of technical support for using computers and software.	☐	☐	☐
e.	Lack of confidence about your ability to take GLOBE measurements correctly.	☐	☐	☐
f.	Difficulty identifying an appropriate site for taking GLOBE measurements.	☐	☐	☐
g.	Difficulties integrating GLOBE into existing curriculum.	☐	☐	☐
h.	Concern about whether GLOBE would be valuable for your students.	☐	☐	☐
I.	Difficulty fitting GLOBE into the school schedule.	☐	☐	☐
j.	Lack of teacher time to plan for and implement GLOBE activities.	☐	☐	☐
k.	Other (Please describe):________________________________	☐	☐	☐

1.3 Do you have plans to implement GLOBE at a future time?

☐ Yes

When will you start?

____________ Month   ____________ Year

☐ No   *Please continue with question 1.4*

1.4 What kinds of support from the GLOBE program would increase the likelihood that you would start implementing GLOBE? ***(Scale: 1= Would make no difference, 2= Would help somewhat, 3= Would be a big help)***

		1	2	3
a.	A phone call from a computer technician from the GLOBE Help Desk.	☐	☐	☐
b.	More guidance on how to relate GLOBE activities to existing curricula.	☐	☐	☐
c.	A local training session with other GLOBE teachers.	☐	☐	☐
d.	Help in obtaining computer equipment.	☐	☐	☐
e.	Help in obtaining a World Wide Web connection.	☐	☐	☐
f.	Other. Please describe:____.	☐	☐	☐

Thank you very much for your help in completing this survey. If you have any further comments, you may use the space below. Please use the enclosed business reply envelope to return the survey to:

GLOBE Evaluation
SRI International
Room BS 123
333 Ravenswood Avenue
Menlo Park, CA 94025

GLOBE Teacher Survey

PART II

GLOBE Implementation at Your School

1. When did your school begin implementing GLOBE activities with students? ***(Mark one.)***

- ☐ Spring 1995
- ☐ Summer 1995
- ☐ Fall 1995
- ☐ Winter 1996
- ☐ Spring 1996

2. How many teachers at your school are implementing GLOBE activities with students?

Number of Teachers ____

3. How many students at each grade level participate in GLOBE at your school?
(Mark 0 where appropriate.)

Grade level:	K-3 (ages 5-8)	4-5 (ages 9-10)	6-8 (ages 11-13)	9-12 (ages 14 and older)
Number of students:	_____	_____	_____	_____

4. In what setting(s) do students participate in GLOBE activities at your school? ***(Mark all that apply.)***

- ☐ regular class
- ☐ lunch or after-school interest group
- ☐ pull-out program (students taken out of regular class for this activity)
- ☐ other (please specify): ________________________________

5. In what classes is GLOBE being implemented at your school? ***(Mark all that apply.)***

- ☐ Comprehensive Elementary Class
- ☐ Earth Science
- ☐ Physics
- ☐ Environmental Science
- ☐ Biology
- ☐ Chemistry
- ☐ General Science
- ☐ Mathematics
- ☐ Technology/Computer Science
- ☐ Geology
- ☐ Social Studies
- ☐ English/Language Arts
- ☐ Other (provide class title) ____

GLOBE Classroom Activities

6. **Think about the class or other setting in which you do the most GLOBE-related work with students. With how many students do you work directly in carrying out the GLOBE program?**

Grade Level	Number of Students	Grade Level	Number of Students
K (age 5)	________	7 (age 12)	________
1 (age 6)	________	8 (age 13)	________
2 (age 7)	________	9 (age 14)	________
3 (age 8)	________	10 (age 15)	________
4 (age 9)	________	11 (age 16)	________
5 (age 10)	________	12 (age 17)	________
6 (age 11)	________		

7. **Again, think about the class or other setting in which you do the most GLOBE-related work. In a typical week, how many of your students engage in each GLOBE activity?**
(Mark one for each activity.)

		Nobody Does This Currently	1-4 Students	5-10 Students But Not the Whole Class	The Whole Class or More Than 10 Students
a.	Take a measurement for GLOBE.	☐	☐	☐	☐
b.	Enter GLOBE data on the computer.	☐	☐	☐	☐
c.	Use the visualization software.	☐	☐	☐	☐
d.	Compare different sets of GLOBE data.	☐	☐	☐	☐
e.	Predict how data might change over the next few weeks/months.	☐	☐	☐	☐
f.	Help other students with GLOBE activities (peer or cross-age tutoring).	☐	☐	☐	☐
g.	Write about a GLOBE activity or data set.	☐	☐	☐	☐
h.	Telecommunicate with other GLOBE schools.	☐	☐	☐	☐
i.	Talk/interact with a scientist.	☐	☐	☐	☐

8. **Have you designed any additional investigations or data analysis activities that build upon the basic GLOBE program?**

☐ Yes. *Please describe any such activities that you have found to be particularly successful with your students.*

____

____

____

☐ No

GLOBE's Impact on Students

9. How much have GLOBE activities helped your students to improve their skills in the following areas?
(Scale: 1= Not at All, 2= Not Very Much, 3= Somewhat, 4= Very Much, 9= Don't Know)

		1	2	3	4	9
a.	Measurement skills	☐	☐	☐	☐	☐
b.	Observational skills	☐	☐	☐	☐	☐
c.	Map skills	☐	☐	☐	☐	☐
d.	Technology skills	☐	☐	☐	☐	☐
e.	Ability to work in small groups	☐	☐	☐	☐	☐
f.	Ability to understand, represent, and interpret data	☐	☐	☐	☐	☐
g.	Critical thinking skills	☐	☐	☐	☐	☐
h.	English language skills	☐	☐	☐	☐	☐

10. How much have GLOBE activities increased your students' knowledge in the following areas?
(Scale: 1= Not at All, 2= Not Very Much, 3= Somewhat, 4= Very Much, 9= Does not apply)

		1	2	3	4	9
a.	Hydrology (e.g., properties of water, soil moisture)	☐	☐	☐	☐	☐
b.	Atmosphere and climate	☐	☐	☐	☐	☐
c.	Biology (e.g., land cover, biometry)	☐	☐	☐	☐	☐
d.	Geography	☐	☐	☐	☐	☐
e.	Remote sensing	☐	☐	☐	☐	☐

11. How many of your students have improved attitudes toward science after taking part in GLOBE as evidenced by the following?
(Scale: 1= No Students, 2= A Few Students, 3= Some Students, 4= Most Students, 9= Don't Know)

		1	2	3	4	9
a.	View of themselves as capable of doing science.	☐	☐	☐	☐	☐
b.	Interest in taking science classes.	☐	☐	☐	☐	☐
c.	View of science as a way to understand the world around them.	☐	☐	☐	☐	☐
d.	Interest in exploring scientific questions outside the classroom.	☐	☐	☐	☐	☐
e.	Time spent describing what they have learned through GLOBE to friends or family.	☐	☐	☐	☐	☐

12. How would you rate your students' levels of interest in the GLOBE program?
(Scale: 1= Not At All Interested, 2= Somewhat Interested, 3= Very Interested, 9= Not Applicable, Students Haven't Done This)

		1	2	3	9
a.	Doing GLOBE activities in general.	☐	☐	☐	☐
b.	Taking GLOBE measurements.	☐	☐	☐	☐
c.	Using computers to work with GLOBE data.	☐	☐	☐	☐
d.	Working on GLOBE with other students at their school.	☐	☐	☐	☐
e.	Communicating with GLOBE classrooms in other schools.	☐	☐	☐	☐
f.	Finding out about GLOBE scientists and their work.	☐	☐	☐	☐

Challenges in Implementing GLOBE

13. How great a challenge has each of the following pedagogical issues been for you as you implemented the GLOBE project this school year?
(Scale: 1= This has been easy, 2= This has been somewhat challenging, 3= This has been a major challenge, 9= Don't know/Have not yet tackled this issue)

		1	2	3	9
a.	Integrating GLOBE with the rest of the curriculum.	☐	☐	☐	☐
b.	Finding time for GLOBE activities, given other curriculum and testing requirements.	☐	☐	☐	☐
c.	Presenting GLOBE concepts and activities at the right level for your students (e.g., trying to estimate percentage of cloud cover when students haven't learned percentages yet.)	☐	☐	☐	☐
d.	Assessing what students are learning from GLOBE.	☐	☐	☐	☐
e.	Maintaining good student behavior during GLOBE activities/instruction.	☐	☐	☐	☐

14. How great a challenge has each of the following logistical and organizational issues been for you as you implemented the GLOBE project this school year?
(Scale: 1= This has been easy, 2= This has been somewhat challenging, 3= This has been a major challenge, 9= Don't know/Have not yet tackled this issue)

		1	2	3	9
a.	Finding time to prepare for implementing GLOBE activities.	☐	☐	☐	☐
b.	Having time to complete GLOBE activities within the school's schedule constraints (e.g., trying to fit GLOBE activities into lunch period).	☐	☐	☐	☐
c.	Getting support from school administration/other teachers.	☐	☐	☐	☐
d.	Finding funds for acquiring scientific measurement instruments.	☐	☐	☐	☐
e.	Availability of instruments for data collection (e.g., on weekends, vacations).	☐	☐	☐	☐
f.	Keeping GLOBE equipment secure (i.e., vandalism, theft).	☐	☐	☐	☐
g.	Getting the data collection equipment to work properly.	☐	☐	☐	☐
h.	Getting to data collection site (e.g., water site).	☐	☐	☐	☐
i.	Getting access to adequate computers.	☐	☐	☐	☐
j.	Obtaining technical support for using computers.	☐	☐	☐	☐
k.	Logging on to the GLOBE server.	☐	☐	☐	☐
l.	Other (please specify): ______________________	☐	☐	☐	☐

15. [OPTIONAL] Do you have a useful strategy to share for overcoming a significant challenge in implementing GLOBE? If so, please describe the challenge and your strategy for dealing with it.

____
____
____
____
____
____

GLOBE Teacher Support

16. From whom did you receive GLOBE training? ***(Mark one.)***

☐ Training workshop organized by GLOBE staff
☐ Training at your school or a nearby location from a local GLOBE teacher
☐ International GLOBE training workshop
☐ I have not been trained (Skip to question 18.)
☐ Other ______________________________

17. When did you receive your GLOBE training?

☐ Spring 1995 ☐ Fall 1995 ☐ Spring 1996
☐ Summer 1995 ☐ Winter 1996

18. How often have you used these GLOBE services or materials?
(Scale: 1=Not at all; 2=Once; 3=Occasionally; 4=At least once a week)

		1	2	3	4
a.	Teacher's Guide	☐	☐	☐	☐
b.	Help Desk	☐	☐	☐	☐
c.	Scientist's Corner	☐	☐	☐	☐
d.	GLOBE School Mail	☐	☐	☐	☐
e.	GLOBE Student Data Archive	☐	☐	☐	☐
f.	Data visualizations	☐	☐	☐	☐

19. How much value would you place on the following potential additions to the GLOBE materials provided to teachers?
(Scale: 1=Not at All Valuable, 2= Somewhat Valuable, 3=Valuable, 4= Very Valuable.)

		1	2	3	4
a.	Modularized (stand-alone) teacher's guidebooks for each study area (integrating background information, instrumentation, measurement protocols, and educational activities).	☐	☐	☐	☐
b.	A set of activities integrating science themes that cut across GLOBE study areas.	☐	☐	☐	☐
c.	A statement of the specific learning outcomes fostered by GLOBE activities.	☐	☐	☐	☐
d.	More information about the GLOBE science investigators and their research.	☐	☐	☐	☐
e.	Ideas for investigations and analyses students can conduct with their GLOBE data.	☐	☐	☐	☐
f.	More information on how to adapt GLOBE for my grade level.	☐	☐	☐	☐
g.	Guidance on how to implement GLOBE at the school level (in multiple classrooms)	☐	☐	☐	☐
h.	Other (Please describe.)				

____
____

20. What additional kinds of support from the GLOBE program would improve your implementation of GLOBE activities?

School Information

21. Are schools within your district working together to implement GLOBE?

☐ Yes. *Please describe*:

☐ No

22. How would you describe your school? ***(Mark one in each category.)***

(Mark one)	***(Mark one)***	***(Mark one)***
☐ public	☐ rural	☐ regular
☐ private	☐ suburban	☐ alternative (e.g. serving a special population)
	☐ urban	

23. About what percentage of students in your school would you estimate qualify for free or reduced-price lunch?

☐ Fewer than 15%
☐ 15-29%
☐ 30-49%
☐ 50% or more

Thank you very much for your help in completing this survey.

If you have any further comments, you may use the space below.

OMB No. 0648-0310
Approval Expires: May 31, 1996

A SURVEY OF 4TH GRADE STUDENTS PARTICIPATING IN THE GLOBE PROGRAM

The public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to The GLOBE Program, 744 Jackson Place, Washington, D.C. 20503.

The information provided by respondents in this survey will be used to prepare summaries in aggregate form that do not identify individual respondents. The identity of respondents will be assured to the extent provided by law, including the Freedom of Information Act. Reasonable steps will be taken in the processing and analysis of respondent data to attempt to avoid any unintentional dissemination of information in which respondents and/or their responses may be identified.

Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirement of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB control number.

GLOBE 4th Grade Student Survey
(Form A)
(Elementary School)

Name: ________________________________

Today's Date ______________ **(month/day/year; example: 11/20/96)**

My birthdate_______________ **(month/day/year)**

I am a : _____ **Boy** ______ **Girl**

Part I

We want to know what students in the GLOBE program are doing and what they like and don't like about GLOBE. Please tell us what you think by answering these questions. Be sure to mark only ONE box for each question.

1. How much do you like these parts of GLOBE?

		Like It a Lot	Like It a Little	Do NOT Like It	Our Class Does Not Do This
a.	Talking about weather, the earth, and water.	☐	☐	☐	☐
b.	Taking measurements for GLOBE.	☐	☐	☐	☐
c.	Putting GLOBE data on the computer.	☐	☐	☐	☐
d.	Looking at pictures taken by satellites.	☐	☐	☐	☐
e.	Looking at the GLOBE data collected by students in other places.	☐	☐	☐	☐

2. Think about the last week, from Monday through Friday. Make a mark to show whether YOU did each of these things last week.

		Yes, I Did It Last Week	NO, I Did Not Do It Last Week	I'm Not Sure
a.	Took a measurement for GLOBE.	☐	☐	☐
b.	Entered GLOBE data onto the computer.	☐	☐	☐
c.	Compared a GLOBE measurement to data your class collected some time in the past.	☐	☐	☐
d.	Talked about how something your class measures for GLOBE might change in the future.	☐	☐	☐
e.	Helped other students work on GLOBE.	☐	☐	☐
f.	Used the computer to send messages to students at another GLOBE school.	☐	☐	☐
g.	Used the computer to send a message to a scientist.	☐	☐	☐
h.	Talked to your parents or other adults about what you do in GLOBE.	☐	☐	☐
i.	Wrote something about GLOBE.	☐	☐	☐

3. Mark each statement to show whether it is true or false.

		True	False	I'm Not Sure
a.	I like doing GLOBE activities.	☐	☐	☐
b.	Working with other students makes GLOBE more fun.	☐	☐	☐
c.	GLOBE has taught me how to do more things with computers.	☐	☐	☐
d.	It gets boring taking the same measurements over and over.	☐	☐	☐
e.	I think the GLOBE project will help people understand the earth better.	☐	☐	☐
f.	I don't know why we take the measurements we do for GLOBE.	☐	☐	☐
g.	The measurements my class takes are important for scientists.	☐	☐	☐
h.	What happens at one place on earth can make changes happen in other places.	☐	☐	☐
i.	I like to study science.	☐	☐	☐
j.	Scientists mostly just read books.	☐	☐	☐
k.	Lots of times, you need math to do science.	☐	☐	☐
l.	What we learn from science can help make our world a better place.	☐	☐	☐
m.	I might want to be a scientist when I grow up.	☐	☐	☐
n.	I like to use computers.	☐	☐	☐

4. Think about the things you do when your class is working on GLOBE and the things you do when your class is working on other projects or subjects. Make a mark to show when you do more of each thing.

		More During GLOBE	More When Doing Other Things	About The Same
a.	I work in a group with other students.	☐	☐	☐
b.	I write about what I have learned.	☐	☐	☐
c.	I get mixed up about what I'm supposed to do.	☐	☐	☐
d.	I use a computer.	☐	☐	☐
e.	I help other students learn.	☐	☐	☐
f.	I learn new words.	☐	☐	☐
g.	I get bored doing something I don't care about.	☐	☐	☐
h.	I use my head to figure out something.	☐	☐	☐
i.	I answer questions from a book or worksheet.	☐	☐	☐
j.	I learn how to do something important.	☐	☐	☐

OMB No. 0648-0310
Approval Expires: May 31, 1996

A SURVEY OF 7TH AND 10TH GRADE STUDENTS PARTICIPATING IN THE GLOBE PROGRAM

The public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to The GLOBE Program, 744 Jackson Place, Washington, D.C. 20503.

The information provided by respondents in this survey will be used to prepare summaries in aggregate form that do not identify individual respondents. The identity of respondents will be assured to the extent provided by law, including the Freedom of Information Act. Reasonable steps will be taken in the processing and analysis of respondent data to attempt to avoid any unintentional dissemination of information in which respondents and/or their responses may be identified.

Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirement of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB control number.

GLOBE 7th and 10th Grade Student Survey
(Form A)
(Middle and High School)

Name: ________________________________

Today's Date ______________ **(month/day/year)**

Your Birthdate _____________ **(month/day/year)**

Grade: _____ 7th _____10th **Gender:** ______ Male ______ Female

---

Part I

We want to know what students in the GLOBE program are doing and what they like and don't like about GLOBE. Please tell us what you think by answering these questions.

1. When do you do GLOBE activities? (Mark the <u>one</u> best answer.)

_____a. During a regular class or several classes
_____b. During free time, lunch period, club period, or after school
_____c. Both a. and b.

Answer question 2 only if you do GLOBE activities during a regular class.

2. During what kind of class do you do your GLOBE work? (Mark ALL that apply.)

_____a. Science class
_____b. Math class
_____c. Language Arts class
_____d. Social Studies class
_____e. Other (Give class name) _________________________

3. How much do you like these parts of GLOBE?
(Scale: 1 = I like this a lot, 2 = I like this a little, 3 = I do NOT like this, 9 = Our class does not do this)

		1	2	3	9
a.	Talking about weather, the earth, and water.	☐	☐	☐	☐
b.	Taking measurements for GLOBE.	☐	☐	☐	☐
c.	Putting GLOBE data on the computer.	☐	☐	☐	☐
d.	Using the visualization software to look at satellite images.	☐	☐	☐	☐
e.	Looking at the GLOBE data collected by students in other places.	☐	☐	☐	☐

4. Think about the LAST WEEK, from Monday through Friday. Make a mark to show whether YOU did each of these things last week.

		I Did This More Than Once	I Did This One Time	I Did NOT Do This
a.	Took a measurement for GLOBE.	☐	☐	☐
b.	Listened to someone explaining how GLOBE data would be used by scientists.	☐	☐	☐
c.	Entered GLOBE data onto the computer.	☐	☐	☐
d.	Compared a GLOBE measurement to data your class collected some time in the past.	☐	☐	☐
e.	Talked about how something your class measures for GLOBE might change in the future.	☐	☐	☐
f.	Compared GLOBE data your class had collected to data from another GLOBE site.	☐	☐	☐
g.	Created a spreadsheet or other record of GLOBE data.	☐	☐	☐
h.	Helped other students work on GLOBE.	☐	☐	☐
i.	Used the computer to send messages to students at another GLOBE school.	☐	☐	☐
j.	Used the computer to send a message to a scientist.	☐	☐	☐
k.	Talked to your parents or other adults about what you do in GLOBE.	☐	☐	☐
l.	Wrote something about GLOBE.	☐	☐	☐
m.	Did something to improve the environment around your school or community.	☐	☐	☐

5. Mark each statement to show whether you agree or disagree.
(Scale: 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree)

		1	2	3	4	5
a.	I like doing GLOBE activities.	☐	☐	☐	☐	☐
b.	Working with other students makes GLOBE more fun.	☐	☐	☐	☐	☐
c.	GLOBE has taught me how to do more things with computers.	☐	☐	☐	☐	☐
d.	It gets boring taking the same measurements over and over.	☐	☐	☐	☐	☐
e.	I think the GLOBE project will help people understand the earth better.	☐	☐	☐	☐	☐
f.	I don't know why we take the measurements we do for GLOBE.	☐	☐	☐	☐	☐
g.	The measurements my class takes are important for scientists.	☐	☐	☐	☐	☐
h.	What happens at one place on earth can make changes happen in other places.	☐	☐	☐	☐	☐
i.	Scientists mostly just read books.	☐	☐	☐	☐	☐
j.	Lots of times, you need math to do science.	☐	☐	☐	☐	☐

5. (Continued) Mark each statement to show whether you agree or disagree.
(Scale: 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree)

		1	2	3	4	5
k.	What we learn from science can help make our world a better place.	☐	☐	☐	☐	☐
l.	After doing GLOBE, I am more interested in taking science classes.	☐	☐	☐	☐	☐
m.	I might want to be a scientist.	☐	☐	☐	☐	☐
n.	I like to use computers.	☐	☐	☐	☐	☐

6. Think about the things you do when your class is working on GLOBE and the things you or have done at other times in your science classes. Make a mark to show whether or not you do these things more often when working on GLOBE.

		More During GLOBE	More When Doing Other Things	About The Same
a.	I work in a group with other students.	☐	☐	☐
b.	I write about what I have learned.	☐	☐	☐
c.	I get mixed up about what I'm supposed to do.	☐	☐	☐
d.	I use a computer.	☐	☐	☐
e.	I help other students learn.	☐	☐	☐
f.	I learn new words.	☐	☐	☐
g.	I get bored doing something I don't care about.	☐	☐	☐
h.	I think of my own idea for how to solve a problem.	☐	☐	☐
i.	I answer questions from a book or worksheet.	☐	☐	☐
j.	I work on a science problem that is like a real-life problem I care about.	☐	☐	☐