GLOBE YEAR 10 EVALUATION

INTO THE NEXT GENERATION

Prepared by SRI International for the GLOBE Program

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C O N T E N T S

Tables and Figures

CHAPTER 1

INTRODUCTION

SRI International (SRI) prepared this evaluation research report for the GLOBE Program. This is the 10th in a series of annual evaluation reports that SRI has submitted to the GLOBE Program since the Program's inception in 1995. The Year 10 report details research from the 2004–05 school year and focuses on how the findings can inform the vision for the GLOBE Program as it moves into its second decade. As previous reports do, this evaluation focuses on the experiences of students, teachers, and partners from the GLOBE Program in the United States. In addition, the report presents analyses of teacher and student outcomes. The present report is the final evaluation report SRI will prepare under its current grant.

The Year 10 evaluation report begins with a summary of GLOBE Program growth using established indicators of program expansion, including levels of student data reporting and the number of new teachers trained. We then report on two specialized studies—first presenting an analysis of the effects of partners' activities to provide teachers with initial protocol training and follow-up on GLOBE implementation and teacher practice and then reporting on the results of a quasi-experimental student achievement study. The penultimate chapter describes the GLOBE ONE case study, which focuses on evaluating a GLOBE ONE field campaign and providing recommendations for fostering GLOBE Learning Communities. We conclude the report with a larger discussion of key findings from the Year 10 evaluation study, connecting our conclusions with the new direction of the GLOBE Program and providing recommendations to inform and further the Program's development.

Introduction to the Year 10 GLOBE Report

Overview of GLOBE and Developments in 2004-05

GLOBE is an environmental science and education program aimed at joining student and scientist efforts to further understanding of the Earth by conducting research in five key environmental investigation areas: Atmosphere, Hydrology, Soils, Land Cover, and Phenology. Since its inaugural year in 1994, when 1,365 teachers were trained in the United States, the GLOBE Program has grown significantly in its scale and reach. To date, GLOBE has trained over 33,000 teachers from 16,000 schools, and the GLOBE Web site contains more than 13 million student-reported data points. The Program currently operates in 110 countries, with 130 partners in the United States and 109 international partners. Although this report does not focus on the international GLOBE community, the size and reach of the international partners are important since the new vision of the Program aims to include international partners more fully in the core areas of program design and administration.

GLOBE's founding vision was to be a leading environmental science program that would have a significant impact on individuals' learning and understanding of science worldwide. The visibility of the Program when it was founded by former Vice President Al Gore in 1994 helped to take the vision to an international scale quickly. From the beginning, the Program was conceived as a large-scale effort in which students provided ongoing environmental data and scientists analyzed the data in their own research. The founding vision was ambitious and succeeded in growing the Program to international visibility in a relatively short time. That founding vision included three core goals that have remained the same through the first 10 years:

- To enhance the environmental awareness of individuals throughout the world.
- To contribute to scientific understanding of the Earth.
- To help students reach higher levels of achievement in science and mathematics.

Leadership and management of GLOBE's operations from 1994 until summer of 2003 were located first in the National Oceanic and Atmospheric Administration (NOAA) and then in the National Aeronautics and Space Administration (NASA), with key support from the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Departments of Education and State. Since 2003, NASA has had a cooperative agreement with the University Corporation for Atmospheric Research (UCAR) and Colorado State University (CSU) for management of GLOBE, and these two organizations have worked closely with NASA and NSF to develop the new vision of GLOBE that will carry the Program into its second decade. Changes associated with the new cooperative agreement include giving much more responsibility for program leadership to GLOBE's regional and international partners, as noted above.

GLOBE had many developments and changes in the 2004–05 school year. Many GLOBE schools participated in the October 2004 Contrail Count-a-thon—a 2-day, focused campaign in which students recorded observations of contrails and submitted their data online. In observance of National Environmental Education Week, GLOBE released the Cloud Protocols Online Teaching

Module in April 2005, which is designed to help teachers and trainers better understand the science of clouds. Perhaps most importantly, the 2004–05 school year marked the beginning of a new era for GLOBE, when the results of a year-long comprehensive internal study culminated in a set of recommendations and a bold new direction for the Program. The new vision for the Program is known as the Next Generation GLOBE (NGG).

Next Generation GLOBE: The Vision

The GLOBE Program has grown markedly since its inception, and in the past year program officers have outlined a new vision for what the Program can accomplish as it moves into its second decade. In the coming year, GLOBE will change more than it has in any other single year since its inception; scientists will take on new roles, education goals will take on more importance, and the Program will begin working more closely with its international partners. The fundamental details of the changes were outlined in a White Paper produced by the GLOBE Program Office and published on the GLOBE Web site (The GLOBE Program, 2005), as well as in the presentation "Next Generation GLOBE" at the 9th annual GLOBE conference in August 2005.

NGG will introduce three broad new approaches to program implementation in accordance with recommendations from the GLOBE self-study and review. First, countries participating in the GLOBE Program will be organized into regional consortia. These consortia will be assisted by the GLOBE Program Office and will have a more significant role in advising the GLOBE directorate by means of their membership on the GLOBE International Advisory Committee. Second, the work of GLOBE will take place under the auspices of a projects-based management approach, which will support two kinds of projects. These projects either will be based on partnerships between GLOBE and NSF or will be NASA-funded integrated Earth Systems Science programs. NSF has just released its program announcement for future GLOBE science grants, reflecting this new focus.

Finally, the Program will establish GLOBE Schools Networks (GSNs). The GSNs represent a shift away from working with individual teachers toward a focus on helping schools that are implementing GLOBE to network with each other. The Program will establish criteria to designate schools as "GLOBE schools" and will work with partners to support selected schools more closely in the context of specific projects rather than general data collection by individual teachers and their students.

In addition to the broad changes in program implementation, a number of specific areas of how GLOBE is organized and run will be affected by the changes under NGG. The new areas of focus are intended to respond to requirements of GLOBE'S key funders, as well as the perceived need for GLOBE to adjust its priorities as it enters its second decade. The key areas, as described in the White Paper, are summarized for this report and presented in Table 1-1.

Table 1-1. Summary of NGG Program Changes

Program Area	Original GLOBE	New Generation GLOBE
Resource Allocation	Resources were preallocated to support scientists' distinct research areas for 5 years at a time.	Funding will be allocated to support specific projects and basic program operations on a yearly basis; science funding will require GLOBE scientists to collaborate with large interdisciplinary, interagency projects.
Focus	GLOBE products and services covered a broad range of scientific areas, countries, and partners, and the project of global data collection was ongoing.	The new GLOBE aims to align program resources in support of approximately three to five large, focused projects that last about a year.
Science	The goal was for scientists to conduct Earth science research using student-collected data and publish their results in peer-reviewed publications.	New GLOBE scientists from the Integrated Earth System Science Projects (IESSPs) will focus on connecting their cutting edge scientific investigations on the Earth system to the interests and learning goals of students and teachers. Scientific publications will no longer be a measure of program success, but will still be encouraged.
Partners	Partners around the world worked to support the larger goal of building the worldwide GLOBE database so that GLOBE scientists in the United States could conduct their investigations and projects.	GLOBE will provide regional consortia of partners with information and advice, and encourage their involvement in IESSPs. The regional consortia will be responsible for organizing and supporting regional projects.
Measures of Success	GLOBE contracted with SRI International to carry out evaluation of specific, agreed-upon issues in program development.	GLOBE intends to work with its partners and other groups to measure program impact by doing internal, ongoing evaluation. Evaluation will be required of new NSF grants to scientists.
Educational Materials Development	The Teacher's Guide was the core of the educational materials for teachers. The focus of the Teacher's Guide was to provide teachers with scientific background and procedures to help them implement the GLOBE protocols and accurately collect data for scientific use.	NGG will develop new materials focused on the educational use of data by students. The Teachers' Guide will be modified to help teachers encourage and support student research using real data (either students' own or data collected by large science programs).
Professional Development	Classroom teachers received training from GLOBE partners on how to accurately use GLOBE protocols with their students.	New emphasis will be placed on preparing teachers to facilitate student research and inquiry with GLOBE. In addition, professional development in NGG will include online content, including online science courses to provide teachers with the science content knowledge they need. Finally, scientific audiences wishing to learn more about education will also have access to the NGG professional development activities.
Sustainability	GLOBE activities were funded by the U.S. Federal Government and managed first by NOAA, then NASA, and now UCAR.	The GLOBE Program will seek support from other government and nongovernmental sources and become self-sufficient by forming a GLOBE independent nonprofit organization.
Technology	Technology use was focused on designing and maintaining the GLOBE Web site as a place to archive student data for scientific use.	The GLOBE Web site will be redesigned to focus on education and be used to help facilitate and support collaboration between GLOBE schools and between schools and scientists.

NGG will decentralize responsibility for GLOBE management, administration, and fundraising by increasing the importance of the international group of GLOBE partners. Overall, the GLOBE Program Office will aim to consolidate its resources and reorganize the Program to meet the demands of a more constrained funding structure.

One of the most significant changes in NGG will be in the role of science and scientists in the program. No longer will a core program goal be for GLOBE scientists to do studies using student data and publish results in peer-reviewed publications. Science will still be an important component of the GLOBE Program, but in NGG the focus will be on more closely meeting the science teaching and learning needs of educators. Scientists will be involved with the Program, but via specific, focused projects that last about a year, rather 5 years. Furthermore, teacher training will include increasing teachers' knowledge of science content, rather than simply assuming that they have the content knowledge to teach GLOBE. Past evaluation findings have revealed that teachers need more support to help their students understand science and do their own research projects. Essentially, the Program will move from being a science and education program to being an education and science program that puts education first by supporting teachers in learning about science and teaching their students how to do scientific research projects with real data.

Although the Year 10 GLOBE evaluation questions and activities were not part of the new GLOBE, the findings and recommendations in this report are directly applicable to NGG's vision, especially the professional development study and the GLOBE ONE case study. The professional development study in Chapter 4 looks at GLOBE training and can inform GLOBE's planning process as program developers seek to create more teacher-focused professional development in the new GLOBE. That study considers which aspects of teacher professional development are necessary to promote student inquiry in GLOBE, as well as what is required to support more protocol implementation and data reporting. Further, the GLOBE ONE case study in Chapter 5 can shed light on best practices for planning and conducting the focused projects, field campaigns, and projects of limited duration that are part of the NGG vision. On the whole, we believe the findings in this evaluation report will prove useful to the program developers as they reshape GLOBE into NGG and strive to remain faithful to the Program's core goals and principles.

Year 10 Report: Key Research Questions and Activities

This year's GLOBE evaluation sought to address the following questions:

- To what extent is the GLOBE Program growing in scale and reach, in terms of metrics traditionally used to measure growth?
- In classrooms where GLOBE is implemented, which aspects of implementation are important for improving students' knowledge and inquiry skills?
- Can our assessment instruments reliably measure specific subscales of content and inquiry?
- What kinds of professional development activities in GLOBE are associated with increased levels of program implementation?

- What kinds of professional development activities in GLOBE are associated with increased teacher knowledge and changes to science teaching practice?
- How do support and follow-up after professional development influence program implementation and teacher knowledge and changes to science teaching practice?
- To what extent did GLOBE ONE achieve a balance of education and science goals, such that both educators and scientists could succeed in achieving their aims through the project?
- How well did GLOBE ONE's supports for student inquiry facilitate teachers and students engaging in their own investigations using GLOBE ONE data?

To measure the growth of the program, we summarized data available in the GLOBE Data Archive. These data include the number of teachers trained, number of schools reporting data, persistence in data reporting from year to year, and GLOBE Honor Roll schools. The number of schools on the Honor Roll provides an indicator of whether schools are meeting scientists' goals for frequency of data reporting within particular investigation areas. Results of these analyses appear in Chapter 2 of the report.

To analyze the effects of GLOBE on student inquiry skills, we conducted a quasi-experimental study in 46 classrooms in the U.S. Midwest. As part of this study, we administered a test used in previous years designed to measure how well students could plan an investigation and analyze data focused on content students are likely to acquire when they collect and analyze Atmosphere data. To mitigate selection bias in our study, participating classrooms in the study all had GLOBE-trained teachers, but some classroom teachers did not implement the program with their students and served as a comparison group for the study. Results of this study appear in Chapter 3 of the report.

To study professional development in GLOBE, we analyzed data from 454 teachers associated with 28 of the most active partners in the United States. Data from surveys asked teachers to report on their professional development experiences, level of implementation of GLOBE, and perceived effects of their GLOBE training on their knowledge and practice. We used data from partners about the design of their initial protocol training activities and from the Data Archive to validate teacher reports of their implementation levels. Results of these analyses appear in Chapter 4 of the report.

To analyze student-scientist partnerships in the context of focused projects of the type NGG hopes to foster, we conducted a case study of the GLOBE ONE field campaign. As part of our study, we conducted interviews with teachers, scientists, and local partner staff members involved in the project. In addition, we conducted site visits in which we observed classrooms and training sessions and spoke with students in focus groups. We analyzed the data from these case studies by using a grounded-theory approach, iteratively developing a set of hypotheses and explanations of patterns in our findings from a basic set of codes derived from interview data. Results of the case study analysis appear in Chapter 5 of the report.

In our final chapter (Chapter 6), we present some conclusions from these studies and develop recommendations for the Program, focusing primarily on how the findings can shed further light on ways to advance the vision for GLOBE outlined in the NGG document.

CHAPTER 2

PROGRAM GROWTH

The GLOBE Program completed its 10th year during the 2004-05 school year. Although growth in the Program was a central goal in the early years, promoting sustained involvement in GLOBE and more high-quality implementation among previously trained teachers has been of more concern to partners recently. This section reviews a number of indicators of program growth: the number of teachers trained, number of schools reporting data, persistence in data reporting, and number of schools on GLOBE Honor Rolls. Each of these indicators is introduced and results are presented following the note about data sources, below.

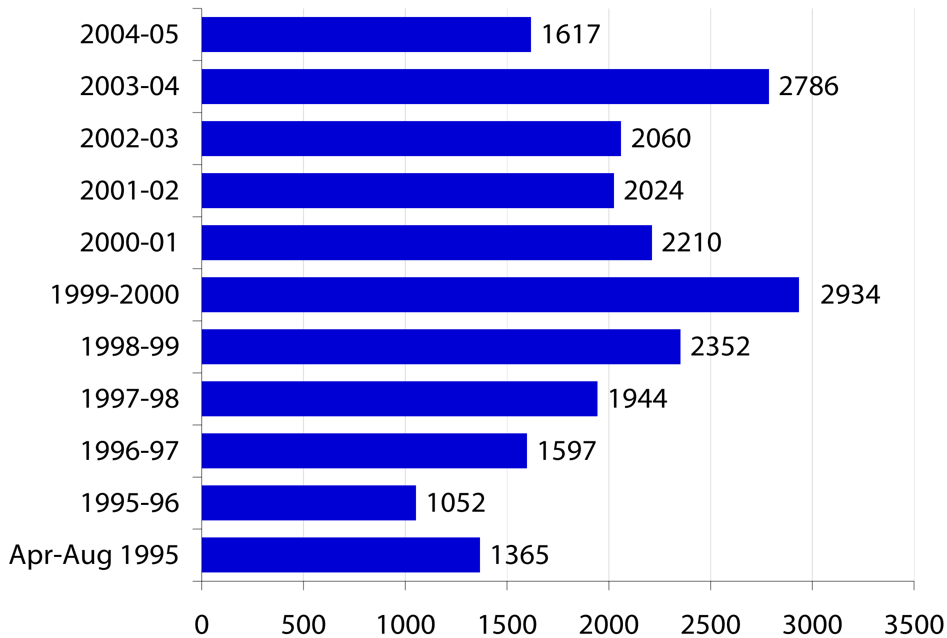
Data Sources for Growth Indicators

GLOBE maintains a tracking database, the GLOBE Data Archive, which provides the data sources for most of this section of the report. These data sources provide useful indicators of program growth, but the indicators have limitations that are important to understand when looking at the results. First, the database must be updated by GLOBE partners when they train teachers, and by students and teachers for the data they collect. GLOBE partners may either update the database as training occurs, or they may wait and do the data entry when more training sessions have been held. Additionally, some teachers who have signed up for training may be entered in the database in advance of the training but then are not able to attend. For schools, we know that data entry can be a challenge because, for example, of the time needed or the lack of reliable Internet access, and therefore the database may not reflect all the schools collecting data. Consequently, the numbers we present for teachers trained and for data reporting are for the time frame described and are precise to the extent that data are not added (or deleted in the case of teachers trained) after the date of retrieval. Despite these limitations, we are confident that the numbers reported here accurately reflect trends and are a close estimate of activity in the Program.

Number of Teachers Trained

Figure 2-1 shows a downward trend in the number of teachers trained in the United States. The peak year was 1999-2000 (2,934 teachers), followed by 2003-04 (2,786). Training numbers in 1997-98 and 1998-99 were similar to the years between the two peak years. In 2004-05, however, the number of teachers trained dropped to levels similar to 1996-97 and earlier. This decline is probably attributable to factors identified in the partner survey conducted in 2003, in which partners highlighted lack of funding as the major issue they faced. Funding sources used in earlier years of the Program have disappeared without replacement, making it difficult for partners to offer training. In addition, partners have responded to the need of trained teachers to have ongoing support and so have begun to direct more of their efforts at helping them than toward recruiting new teachers (Penuel, Korbak, Lewis, Yarnall, & Zander, 2004).

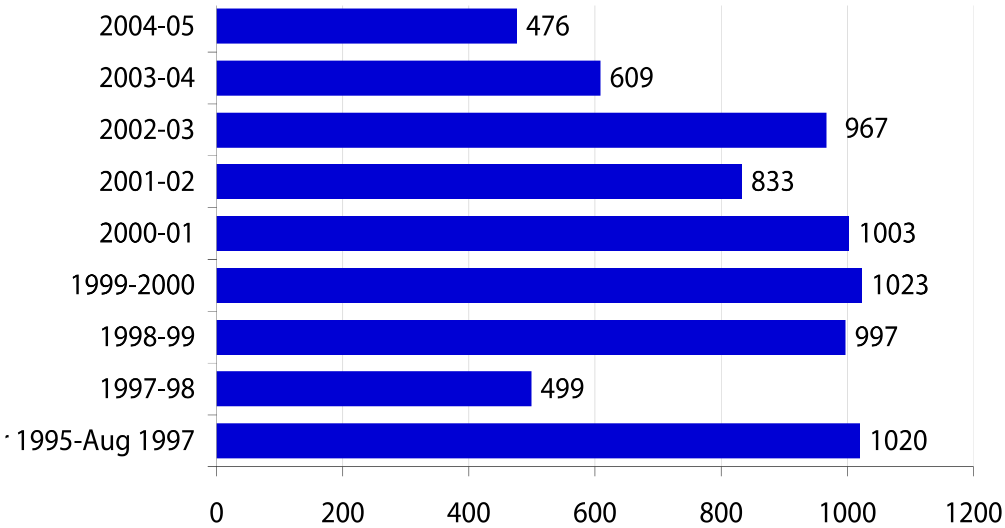
Figure 2-1. Number of Teachers Trained in the United States, by Year*



** Bars depict 12-month (September-August) training totals, except as noted in 1995.*

Similarly, Figure 2-2 shows a downward trend in the number of teachers trained internationally. The two peak years were 1999-2000 and 2000-01, bracketed by similar levels from 1998-99 through 2002-03. The number of teachers trained internationally dropped to 476 in 2004-05, reaching its lowest level since the beginning of the program.

Figure 2-2. Number of Teachers Trained Internationally, by Year*



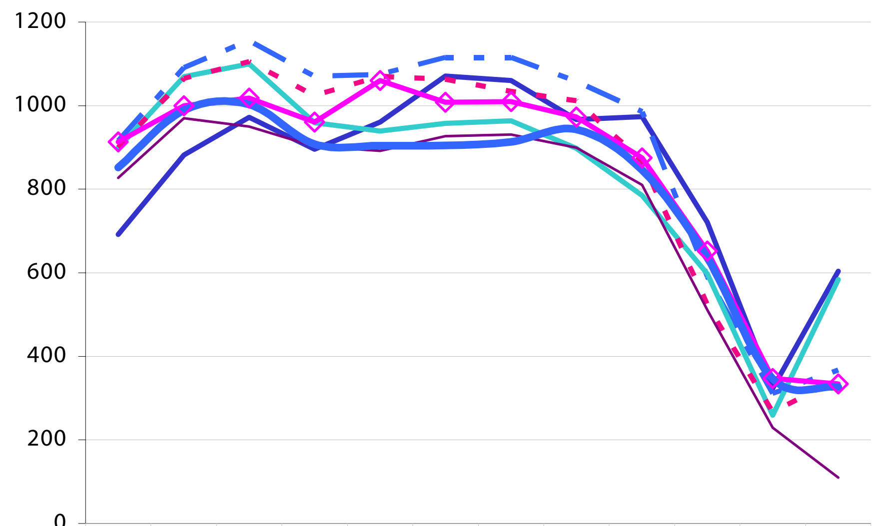
** Bars depict 12-month (September-August) training totals, except as noted in 1995–97.*

Trends in GLOBE Data Reporting

The number of schools reporting data over the last 3 years has remained relatively stable. In 2004-05, there was a slight increase in the number of schools, to 1,729 from 1,623 in 2003-04, but this number is slightly less than the 1,893 schools that reported data in 2001-02. Of the schools that reported data in 2004-05, 570 were schools reporting data for the first time. The peak year for number of schools reporting data continues to be 1999-2000 in all months except June through August (Figure 2-3). However, the numbers of schools reporting that year are only slightly higher than those in other years, for the most part.

For the 2004-05 school year, data reporting fell in the middle of the range reported in the past. The pattern in the number of schools reporting data by month overall was similar to the patterns of the previous 6 years. There was a drop in the number of schools reporting data from November through March 2004-05, reaching the lowest levels of the years presented from January through March (904, 905, and 913 schools respectively). Nonetheless, these levels are very similar to those of the other months of the year. The dropoff in reporting typically seen in July and August did not occur in 2004-05 as in 2003-04. It is possible that automated data reporting for some protocols accounts for the lack of a dropoff in 2004-05.

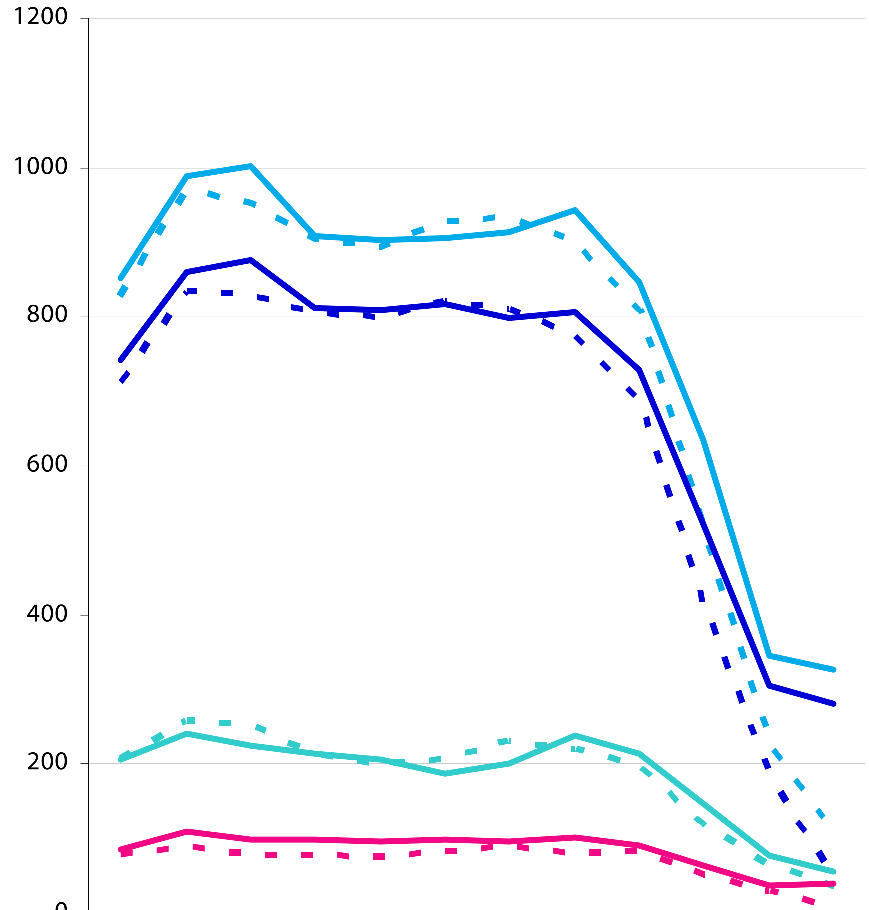
Figure 2-3. Number of Schools Reporting Data Overall, by Month and Year



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1998-99	692	882	972	896	961	1071	1060	967	974	721	323	604
99-2000	916	1091	1156	1070	1075	1115	1115	1058	985	591	311	367
2000-01	899	1069	1100	959	939	958	964	898	785	598	259	584
2001-02	900	1065	1105	1024	1070	1063	1034	1012	867	523	267	346
2002-03	913	1000	1018	961	1060	1008	1010	973	875	652	347	334
2003-04	827	970	950	903	892	927	931	900	810	511	229	110
2004-05	852	989	1003	908	904	905	913	943	846	636	346	326

Figure 2-4 shows the breakdown of the number of schools reporting data by investigation area. For the three areas shown, Atmosphere, Hydrology, and Soils, as well as for those areas overall, there has not been much change from 2003-04 to 2004-05. The number of schools reporting data has remained relatively stable, with increases shown for Atmosphere and for all reports. Once again, these increases are most likely due to the automatic reporting of Atmosphere data, which allows more schools to continue to contribute data during the months when school is not in session.

Figure 2-4. Number of Schools Reporting Data in Years 9 and 10, by Investigation Area

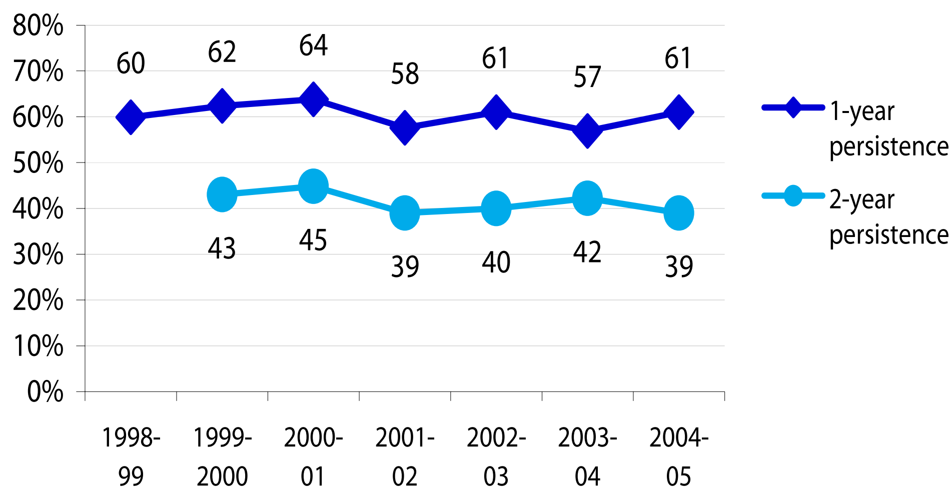


	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
All reports 2004-05	852	989	1003	908	904	905	913	943	846	636	346	326
All reports 2003-04	827	970	950	903	892	927	931	900	810	511	229	110
Atmos 2004-05	741	859	876	812	809	816	798	806	729	523	306	281
Atmos 2003-04	712	834	827	803	798	819	808	775	689	412	184	47
Hydro 2004-05	207	241	226	213	206	187	201	238	215	146	78	56
Hydro 2003-04	206	256	253	212	198	207	231	219	198	121	63	34
Soil 2004-05	85	110	100	99	96	98	97	102	92	64	38	40
Soil 2003-04	77	88	79	77	76	84	88	80	82	50	29	7

Reporting Persistence

Persistence in data reporting has been included as part of the annual evaluation report since 2000-01 as an indicator of the extent to which teachers who begin implementing the program continue to do so. Persistence is critical to GLOBE's scientific mission, but it is also a good indicator of how sustainable the program is within classrooms. Rates for both 1-year persistence, schools that report data 2 years in a row, and 2-year persistence, schools that report data 3 years in a row, are presented in Figure 2-5. There was a peak in the persistence rate in 2000-01 (64% for 1-year persistence and 45% for 2-year persistence), and the lowest rates for both measures occurred in 2001-02. In 2004-05, reporting persistence over 1 year increased slightly, whereas reporting persistence over 2 years decreased slightly, matching the lowest rate of 2001-02.

Figure 2-5. Percentage of Schools Reporting Data Persistently, by Year

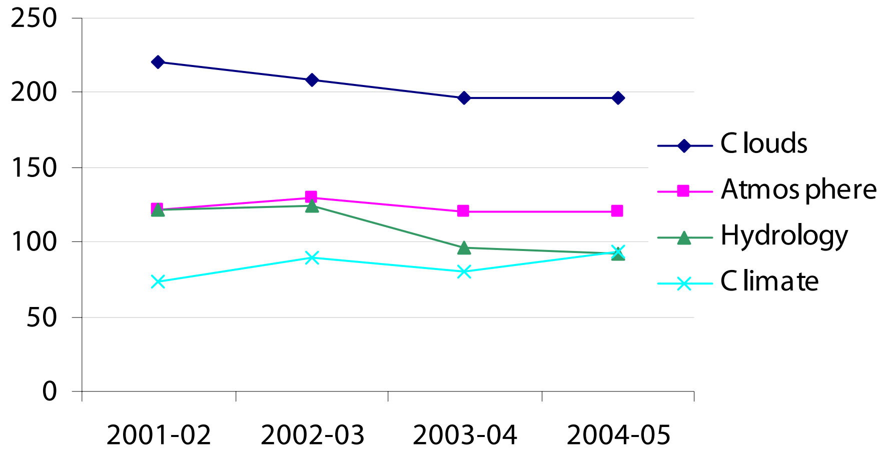


Number of Schools on the GLOBE Honor Roll

Figure 2-6 shows the number of Honor Roll schools for the most commonly implemented investigation areas. Schools must meet the standards for reporting data for an investigation area in order to be named to that area's Honor Roll. Meeting the standards increases the potential for scientists to make use of GLOBE data in their research because the standards reflect quality requirements, such as the number of data points to be collected over a given period of time. It is not intended that all schools meet the Honor Roll requirements; however, it is important to the Program that the proportion of schools on the Honor Roll have a positive relationship to the number of schools reporting data. If more schools begin reporting data, a similar increase in Honor Roll schools is desirable.

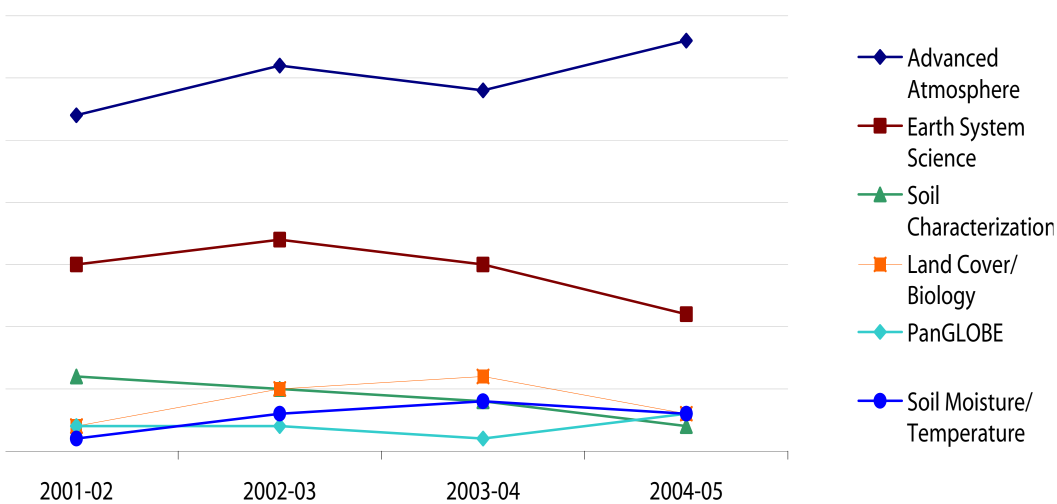
In 2004-05, there was an increase in one investigation area for the number of Honor Roll schools, Climate. There was a slight decrease in the number of schools for Hydrology, and Atmosphere and Clouds remained steady.

Figure 2-6. Number of Honor Roll Schools for Most Commonly Implemented Investigation Areas



For other investigation areas, there were both increases and decreases in the number of Honor Roll schools in 2004-05 (Figure 2-7). The number of schools on the Honor Roll is less than 10 for four of the investigation areas, Soil Characterization, Soil Moisture/Temperature, Land Cover/Biology, and PanGLOBE. Changes in the number of schools reporting in these areas, therefore, cannot be interpreted as trends because there are too few schools on which to base that assumption. The decrease in the number of Honor Roll schools for Earth System Science brings that area to its lowest level. The increase in the number of Honor Roll schools for Advanced Atmosphere brings that investigation area to its highest level.

Figure 2-7. Number of Honor Roll Schools for Other Investigation Areas



Discussion

The results described above indicate that the GLOBE Program has maintained a steady level of activity overall during the last few years. The number of schools reporting data, their persistence in data reporting, and the number of schools on Honor Rolls have all remained relatively steady. At the same time, there has been a decrease in the number of teachers trained, both in the United States and internationally. Given the stability in data reporting and persistence, we might predict that the level of data reporting will drop in the coming years. Data reporting tends to be a “lagging indicator” of program growth, and without a dramatic increase in the persistence rates of teachers in GLOBE, without new teachers coming in at a faster rate to replace those who implement once but do not continue from year to year, the Program could see decreases in data reporting levels. These decreases could be offset if professional development efforts increase the likelihood that teachers who are trained actually become more successful in promoting first-time data reporting among teachers.

CHAPTER 3

GLOBE's Effects on Student Achievement

The relationship of GLOBE implementation and activities to student achievement was assessed through a quasi-experimental evaluation design. Because of practical constraints in the evaluation design, strong *causal* evidence of GLOBE's impact on achievement is not obtainable. Nonetheless, we are able to examine the relationship between student inquiry skills and specific aspects of implementation, including GLOBE-related content covered in class and GLOBE data collection, reporting, and analysis activities.

In an attempt to specify more precisely the content and skills taught by GLOBE, we conducted a factor analysis of the GLOBE assessment instrument this year. By examining subscales of items (items that seem to cohere around a particular activity or concept), we hope to pinpoint more precisely the content sensitive to GLOBE instruction.

Our primary evaluation research questions guiding the analyses were:

- In classrooms where GLOBE is implemented, which aspects of implementation are important for improving students' knowledge and inquiry skills?
- Can our assessment instrument reliably measure specific subscales of content and inquiry?

Methodology

Seven teachers with a record of strong GLOBE implementation were recruited from schools in the U.S. Midwest with the assistance of a regional partner. As a condition of participation, these teachers were asked to engage in data collection, reporting, and analysis activities over the course of 8 weeks (see inset), followed by the administration of a student survey and assessment (see Appendix A and Appendix B). Next, a similar group of six GLOBE-trained teachers whose schools had not reported GLOBE data in recent years were recruited as a comparison group. These schools were screened via e-mail to ensure they were planning either minimal or no GLOBE activities in the following semester. These teachers were asked to administer the same survey and assessment as the GLOBE teachers after instruction about atmosphere content. In addition, all teachers administered a survey measuring interest in and attitudes toward science, using an instrument from prior GLOBE evaluation studies. To partially control for individual achievement differences among students, student ratings of achievement in previous years' science classes were used.

Originally, we planned to pool the data from both groups and analyze the relationship of GLOBE implementation (the intended contrast) to student achievement. Unfortunately, we encountered significant issues of "treatment noncompliance." In particular, we found that many of the comparison group teachers implemented GLOBE to at least a moderate degree. Although not surprising in hindsight (these were GLOBE-trained teachers, after all), this approach reduced the strength and power of our contrast. Thus, an alternate analysis—examining the relationship between empirically assessed implementation variables and student measures—was conducted.

Requirements for participating in GLOBE evaluation

- Conduct at least one GLOBE learning activity with students.
- Collect data by using GLOBE protocols at least three times.
- Complete at least one data analysis activity using GLOBE data with students, in which students have an opportunity to look at and discuss the data they have collected.
- Keep a weekly log of GLOBE activities, using a checklist that will be provided.
- Administer the assessment of student learning, using materials provided and then return those materials to SRI.

Results

Intended and Assessed Implementation

To establish the level of GLOBE implementation in classrooms (teachers often taught more than one classroom in this evaluation), we collapsed data from logs collected weekly from all teachers (see Appendix C) in the study into three levels of implementation: no GLOBE activity, moderate GLOBE activity, and high GLOBE activity. We found that when a teacher taught more than one class, all of the classes for that teacher were independently judged to have the same level of GLOBE implementation; teachers were consistent in their GLOBE use across their multiple classrooms.

Table 3-1 shows the breakdown of assessed GLOBE activity by the intended condition. It appears that there is some relationship between assessed GLOBE activity and intended activity. In the comparison group, none of the six teachers were evaluated as having high GLOBE activity, compared with one teacher in the GLOBE group. However, three of the six comparison group teachers evidenced moderate GLOBE activity, compared with three out of seven GLOBE teachers.

Table 3-1. Number of Teachers, by Assignment Condition and Level of Implementation

	Intended Implementation Group		
Assessed Implementation Level	**Comparison Group**	**GLOBE Group**	**Total**
No GLOBE	3	1	4
Moderate GLOBE	3	2	5
High GLOBE	0	4	4
Total	6	7	13

Assessment Characteristics

The assessment consisted of 14 items aimed at concepts that are taught as part of the GLOBE Atmosphere protocols and learning activities and 15 items to assess inquiry skills with data of the kind students encounter when using selected Atmosphere protocols (e.g., temperature, precipitation). Each item was scored with a partial-credit rubric on a scale from 0 to 3 points.

As part of our investigation, we examined the score data from the assessment for evidence of multidimensionality. We were particularly interested in identifying any items that clustered together (i.e., students either answered correctly or not for the whole group of items). If items fell into clusters, it would suggest that the assessment was measuring multiple constructs.

The examination proceeded in two phases. First, an exploratory factor analysis was conducted of the content and inquiry items separately. The content items did not cluster in any discernible patterns. The inquiry items, however, did cluster into three distinct (albeit correlated) factors. One factor was a single multi-item task on chart reading. A second factor consisted of responses for four items bundled within two tasks, all of which involved interpreting data tables. The main factor, spanning seven questions related to planning a study, was interpreted as a planning factor. Due to the correlation between the two factors of 0.53 and the relatively few items in the second factor, we decided to retain the inquiry scale as a single, intact score.

Subsequent analyses confirmed our decision; our overall results to not change when we break the inquiry scale into two subscales.

Next, the reliability of each scale and subscale was assessed. A reliability coefficient (in this case, we used one known as Cronbach's alpha) indicates how well a scale score is actually measuring a single construct. This is important to know for our subsequent analysis. The reliability of a scale score imposes a limit on the strength of relationships we may observe between that scale score and other implementation variables. When we have scale scores with high reliability, we may be able to detect important relationships with implementation. When a scale score has low reliability, we are less likely to observe significant relationships with implementation features, even when the implementation is truly affecting student knowledge. It is like observing through a telescope with a dirty lens—the constellations of stars (in our case, the relationship of GLOBE implementation and test scores) are harder to distinguish.

The internal reliability of the content scale was 0.58, which is considered low by testing standards. The reliability for the inquiry scale was 0.87, which is quite acceptable. Furthermore, there was a correlation of 0.29 between the two scales, suggesting that these scales are measuring different constructs.[1]

The conclusions we draw from this analysis are: (1) the low reliability of the content items predicts that we will see few, if any, significant associations between the content score and GLOBE implementation; (2) the content and inquiry scales are measuring separable spheres of scientific practice.

Relating Achievement to GLOBE Implementation

At this point, we are ready to ask the question of real interest: how are facets of GLOBE implementation associated with student achievement scores? At the outset, we caution the reader not to read a causal relationship into this analysis. It may well be that higher levels of GLOBE implementation lead to higher achievement test scores. It is also plausible that high-achieving students are in classrooms where a teacher can focus on high-quality GLOBE implementation (as opposed to remedial instruction or classroom management).

In Figure 3-1 and 3-2, we show the distribution of classroom-level mean scores for content and inquiry assessment items. They are arranged in descending order and shaded according to the teacher's level of GLOBE implementation. Visually, two features stand out. First, the mean scores for content items do not vary as much from class to class as do the inquiry scores. This is one predictable consequence of low test reliability—random measurement error tends to obscure differences (contrasts) between groups. Second, there is no visually overwhelming association of GLOBE implementation with lower- or higher-scoring classrooms; on the inquiry items, the No GLOBE classrooms achieved both the lowest and highest scores. Although the

[1] The relatively low correlation of 0.29 could also be due to the moderate reliability of the content scale. A statistic known as the disattenuated correlation takes into account the less than perfect reliability of each measure. It essentially tries to predict what the correlations would be if there were no measurement error whatsoever. If the disattenuated correlations are relatively high, then we can conclude that the lower observed correlations are due to low reliability. If, however, the disattenuated correlations are also low, we can conclude that in fact the two constructs being measured are not well correlated to begin with. The disattenuated correlation between content and inquiry is 0.41, still suggesting considerable independence between the two scales.

inquiry scores indicate that the High GLOBE classrooms scored lower than Moderate GLOBE classrooms (i.e., the black bars cluster a bit lower than the white bars), there is no statistically significant association between mean score and implementation level. That is, we cannot confidently rule out the possibility that the clustering we see is due to random score fluctuations.

Figure 3-1. Classroom Mean Content Scores, by Implementation Level

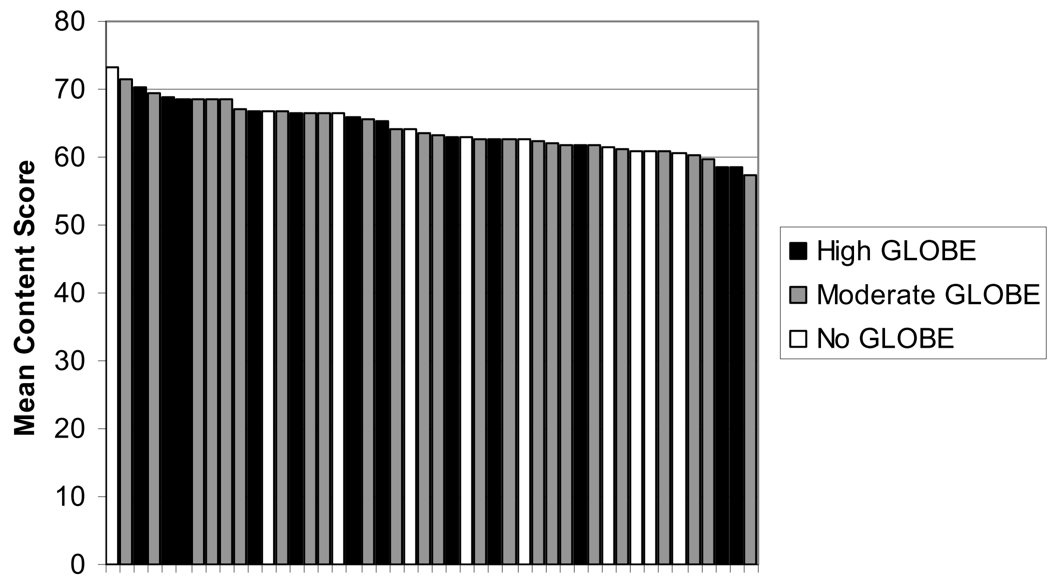
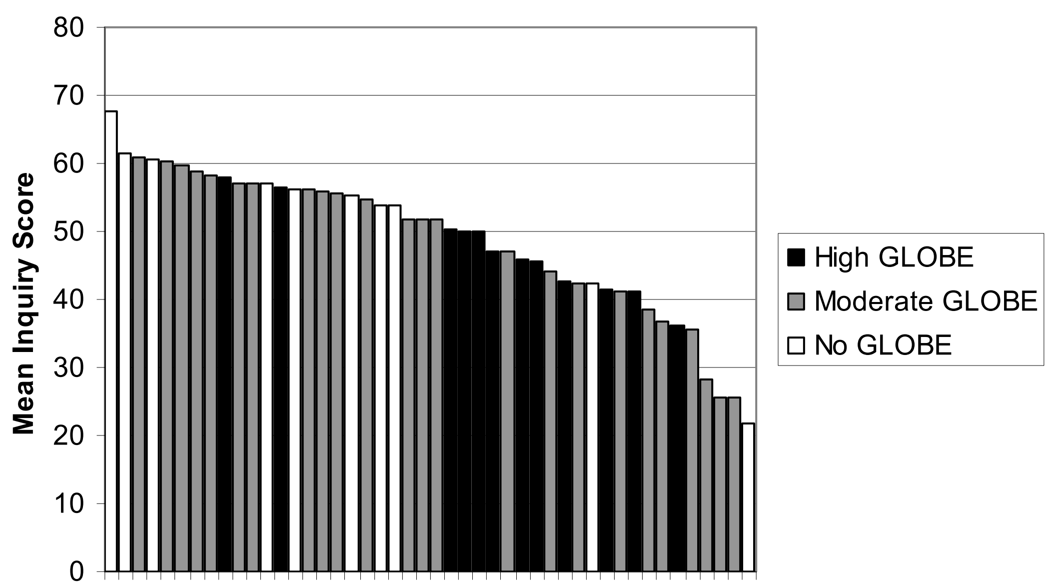


Figure 3-2. Classroom Mean Inquiry Scores, by Implementation Level

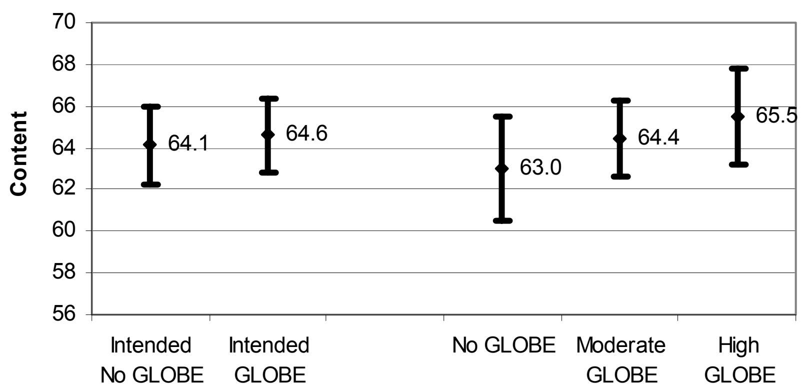


When this analysis is replicated using the intended GLOBE implementation (as opposed to the assessed implementation), the results are essentially the same: there are no discernible differences in achievement between the groups.

A more formal statistical analysis was carried out, examining whether there was a detectable relationship between GLOBE implementation (either intended or assessed) and achievement. A mean score was computed for each category of implementation and 95% confidence intervals computed for that score. The confidence intervals reflect all of the random variation due to sampling and measurement error. We are 95% confident that the mean achievement levels fall within these intervals.

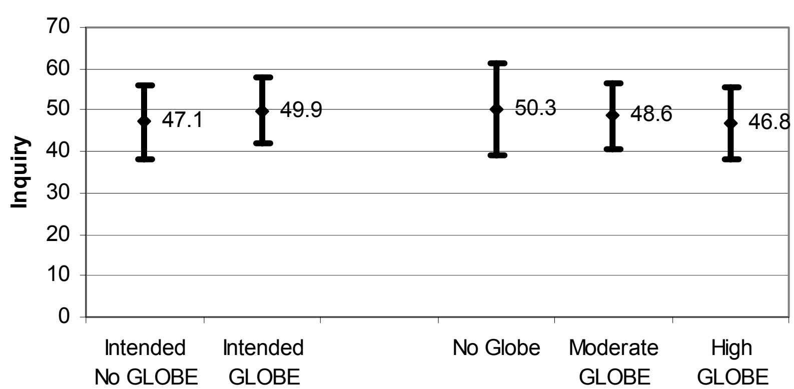
Figure 3-3 shows the mean scores on the content items plotted against levels of GLOBE implementation. First, note that the difference between the No GLOBE and High GLOBE groups was 2.5 points out of 100, a small difference by any standard. Second, the confidence intervals themselves are roughly plus or minus 2 points. Taken together, we cannot declare with confidence that there are persistent score differences between No GLOBE and High GLOBE groups.

Figure 3-3. Group Mean Content Scores, by Implementation Level



A similar result is observed in Figure 3-4 examining the inquiry item scores by implementation level. Once again, there is a small difference (3.5 points) between No GLOBE and High GLOBE groups. This time, the high implementers have the lower mean score. Once again, though, the difference between these mean scores is much smaller than the confidence intervals, and we have no evidence to claim that the level of GLOBE implementation is associated with inquiry scores.

Figure 3-4. Group Mean Inquiry Scores, by Implementation Level



There are several possible contributors to this statistically nonsignificant result. The first and most obvious is that there is truly little relationship between level of GLOBE implementation and item scores. This could be true for several reasons. The items may not adequately capture the specific knowledge and skills taught by these specific GLOBE activities. As mentioned before, the assessment (in particular, the content items) may suffer from low reliability. We also may be observing a relatively homogeneous group of teachers. All of these teachers were recruited from a pool of teachers who had already received GLOBE training and had experience with the program. Whether or not they were implementing specific GLOBE activities, their pedagogical style and habits of mind may have already been influenced in a way that our assessment could not capture.

In addition to the gross categorization of No/Moderate/High GLOBE implementation, we collected more specific measures of implementation activities. These are detailed in Table 3-2.

Table 3-2. Implementation Measures and Definitions

Measure	Definition
Frequency of Protocols	A measure of how many times students conducted protocols, regardless of whether they were similar or different
Breadth of Protocols	A measure of the frequency and breadth of different Atmosphere protocols conducted by students over the course of the study
Breadth of Learning Activities	A measure of the frequency and breadth of different Atmosphere learning activities implemented by teachers
Frequency of Learning Activities	A measure of how many times students completed learning activities, regardless of whether they were similar or different
Frequency of Data Analysis	A measure of the number of times students looked at GLOBE data over the course of the study
Variety of Teaching Methods	A measure of the breadth of methods used to teach the content tested on the assessment.[2]

We examined these six classroom-level implementation variables against the student assessment scores and attitude survey responses. The results, expressed as partial correlations, controlling for prior science achievement, are shown in Table 3-3. Instead of confidence intervals, correlations that are reliably nonzero are indicated in the table.

[2] This index is based on a measure developed by Porter and Smithson (2001) for measuring instruction. In their research, they have found that when combined with measures of the complexity of instruction provided, content coverage helps explain significant amounts of variance in student test scores.

Table 3-3. Correlation of Assessed Implementation and Test Score

	Frequency of Protocols	Breadth of Protocols	Breadth of Learning Activities	Frequency of Learning Activities	Frequency of Data Analysis	Variety of Teaching Methods
Content	n/s	n/s	n/s	n/s	0.16	0.14
Inquiry	n/s	n/s	n/s	n/s	n/s	n/s
Attitude	n/s	n/s	n/s	n/s	n/s	n/s

n/s: Not statistically significantly different from zero.

When we are more specific about the qualities of GLOBE implementation, we find two statistically significant associations, both with the content scale. The first is for data analysis activities; the second, variety of teaching methods, assessed the breadth of content and inquiry skills taught during the study.

None of the implementation variables were significantly associated with scores on the inquiry items or attitude survey. This finding is particularly surprising, given that (1) GLOBE stresses inquiry skills, and (2) the content items had a lower reliability than the inquiry items, so that significant correlations would be harder to detect in the first place.

Again, one should be cautious in drawing any causal inference from this analysis. Although exposure to a greater number of data analysis activities may in fact increase student learning, it may also be that higher-performing classes enable a teacher to cover more content. Nonetheless, we did control for prior achievement in science, reducing the probability of a "selection effect" in which higher-achieving students are assigned to more intensive GLOBE classes.

Discussion

The examination of a relationship between test score and overall measures of GLOBE implementation was inconclusive. However, when examining specific aspects of GLOBE implementation (namely, the quantity of data analysis activities and overall breadth of coverage), we did see a small but reliable positive correlation with scores on the content items. We further note that there were no significant negative associations between GLOBE and scores; participating in GLOBE does not appear to be associated with lower scores on a test of science knowledge.

One particular shortcoming of this particular study design was the recruitment of only GLOBE-trained (and experienced) teachers for both the GLOBE and non-GLOBE intended conditions. Any lasting teacher benefit derived from initial GLOBE training and familiarity with the program would have already occurred and been present in all teachers sampled. That is, we cannot tell whether it is the GLOBE activities themselves that enhance student learning or whether GLOBE participation changes teachers' understanding and pedagogy in enduring ways. If the latter is true, we would not expect to see strong relationships between assessed implementation and achievement.

However, we specifically wanted to rule out the possibility that only "special kinds of teachers" would teach GLOBE in the first place. This is why we selected our comparison group from a pool of GLOBE-trained teachers—they had already volunteered to be part of the GLOBE Program and presumably shared some common characteristics with teachers actively implementing GLOBE.

CHAPTER 4

WHAT MAKES PROFESSIONAL DEVELOPMENT EFFECTIVE IN GLOBE

Policymakers, school and district leaders, and researchers are all increasingly concerned with improving the quality of evidence about the effectiveness of teacher professional development, especially in terms of its impact on desired reform outcomes. At the federal level, for instance, programs at the U.S. Department of Education and the National Science Foundation fund studies aimed at measuring the impact of efforts to improve teacher quality on instruction and student achievement. Within schools and districts, leaders are increasingly looking to providers of professional development for evidence that their activities contribute to improved standardized test scores, especially among low-performing students. And for their part, researchers are increasingly concerned with describing the linkage between the design and conduct of professional development and subsequent improvements to both teacher practice and student learning outcomes (Borko, 2004; Fishman, Marx, Best, & Tal, 2003).

Significant efforts to develop high-quality curriculum materials aligned with standards are also under way, particularly in mathematics and science, in light of findings that existing materials are not sufficient to support student learning (Roseman, Kulm, & Shuttleworth, 2001). In conjunction with these efforts, research is needed that examines what kinds of professional development provide support for the implementation of these curricula. Professional development is widely believed to be required for supporting implementation (Smylie, 1996; Spillane & Thompson, 1997), and some large-scale survey studies have shown how professional development can influence teachers' knowledge and practice (Garet, Porter, Desimone, Birman, & Yoon, 2001; Supovitz & Turner, 2000). These studies provide a strong basis for developing hypotheses about what makes professional development effective, since they rely on nationally representative samples and include teachers who experienced a wide variety of professional development activities. However, three aspects of these studies limit their utility for understanding curriculum implementation: (1) the very breadth of the programs studied to date limits the depth of questions about changes to practice that could be asked of teachers; (2) the models tested in these studies did not include sources of data from professional development providers themselves; and (3) an objective measure of program implementation was not included as part of these studies. These limitations are driven largely by the practicalities required of researchers studying such broad programs; therefore, new research is needed that can illuminate how particular programs' designs and requirements of teachers might influence what makes professional development effective for promoting curriculum implementation.

In this chapter, we report on evidence of effective professional development conditions and practices from a study of 454 teachers taking part in professional development preparing them to implement materials from GLOBE. We drew on multiple sources of data for our study: surveys of professional development providers on the design of their programs, surveys of teachers on their perceptions of professional development and implementation practices, and objective data on implementation obtained from a program database. Unlike previous large-scale studies of professional development, we were able to take advantage of an unusual opportunity to explore what makes professional development effective: a situation in which teachers are being asked to implement a common program with a well-articulated model of implementation fidelity and a readily available objective measure of implementation in which the professional development conditions and practices are allowed to vary significantly from one setting to another by design.

We analyzed the data within a hierarchical linear modeling (HLM) framework (Raudenbush & Bryk, 2002), and we report here on answers to three research questions: (1) What kinds of professional development activities in GLOBE are associated with increased levels of program implementation? (2) What kinds of professional development activities in GLOBE are associated with increased teacher knowledge and changes to science teaching practice? (3) How do support and follow-up after professional development influence program implementation and teacher knowledge and changes to science teaching practice?

Background and Literature Review

In recent years, researchers have increasingly focused on what makes professional development effective. This trend is an improvement compared with the decades in which little attention was directed to the outcomes of professional development and much to evaluations of teacher satisfaction with professional development experiences (Frechtling, Sharp, Carey, & Vaden-Kiernan, 1995). Recent research explores the complex links between the design of professional development, teachers' learning during professional development activities, and subsequent changes in classroom practice (Borko, 2004). In addition, researchers are beginning to take up the challenge of designing studies that can help identify the linkage between the design and implementation of professional development and student learning outcomes (Fishman et al., 2003; Loucks-Horsley & Matsumoto, 1999).

One of the most notable recent studies of professional development effectiveness (Garet et al., 2001) was a large-scale study that used regression modeling to examine how core structural components of professional development funded through the Eisenhower Math and Science program led to self-reported changes in teachers' knowledge and practice. The researchers in this study found evidence supporting the value of the following structural features of professional development: reform orientation (with reform-oriented activities such as teacher study groups being more effective than traditional professional development settings such as workshops or college courses), duration (in terms of both time span and total contact hours), and the collective participation of teachers from the same school. The following core features also contributed to enhanced knowledge and skills and changes in teaching practice: a focus on content knowledge, active or inquiry-oriented learning approaches in the professional development experience, and a high level of coherence with other reform activities and standards in the teachers' local school contexts.

This particular study marked an important advance within the field, because it relied on data from a national probability sample of teachers who had taken part in professional development activities that varied with respect to key features of interest, such as content focus and duration. Many of the features of professional development that Garet et al. (2001) found to be significant predictors of effectiveness had already been identified in the literature as contributing to the quality of professional development (e.g., Hawley & Valli, 1999; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Loucks-Horsley & Stiles, 2001), but before the Eisenhower study, empirical evidence of the relative value of specific professional development features was limited. The researchers who conducted the evaluation of the Eisenhower program took advantage of a significant opportunity to advance knowledge about the features of effective professional development, in that they had access to a nationally representative sample of teachers, for whom professional development activities and self-reported outcomes varied widely. The content of teachers' professional development included targeting improvements to content knowledge, pedagogical strategies, alignment of curriculum and assessment, and a range of other topics (Garet et al., 1999). For some teachers, their professional development activities lasted less than a day, while for others, it lasted several days over a span of several months. Finally, some teachers reported significant changes to their knowledge and practice in multiple areas, while others reported that the professional development activities in which they had taken part had had a limited effect (Garet et al., 2001).

Limitations Associated with Breadth of Professional Development Programs Studied

The breadth of the Eisenhower program makes it difficult to draw conclusions about what makes professional development effective within a single domain, such as science, or for a specific program or set of curriculum materials. The questions that were sensible for Garet et al. (2001) to pose on a teacher survey targeting multiple activities about, for example, subject matter content or specific program outcomes were necessarily general, and therefore harder to use to determine success or failure of implementation of a specific program model beyond a rough approximation. Findings from Supovitz and Turner's (2000) analysis of professional development activities within the Local Systemic Change initiative of the National Science Foundation offer some insight about professional development features that matter most in the domain of science for fostering use of inquiry-oriented instructional materials among teachers. But this study, too, had to rely on general questions about changes to teacher practice that could be answered by teachers involved in each of the 24 different curriculum projects being studied.

Studies of professional development activities connected to individual curricula and programs, however, have the opportunity to examine the influence of specific implementation requirements for teachers—requirements which in science often include access to and ability to use specialized equipment for student inquiry. For instance, specific curriculum materials differ in how they structure opportunities for student inquiry. In the American Geological Institute's *Investigating Earth Systems* curriculum units for studying water, writers provide a broad framework for student investigations, but teachers must adapt the content to address local water and watershed issues (Smith, Southard, & Mably, 2001). By contrast, the *What is the Quality of Water in Our River?* unit from the Center for Highly Interactive Computing in Education (Singer, Marx, Krajcik, & Clay-Chambers, 2000) is highly specified in terms of the activities and investigations teachers conduct with students, highly supportive in terms of pointers to resources, and also educative (Davis & Krajcik, 2005) in terms of support for specific teaching practices. These and other science curricula also differ as to the materials they expect teachers to use, such as consumable kits or laboratory equipment. It is not surprising, then, that teachers need support as part of their initial professional development and implementation in order to successfully adopt curricula requiring significant capability, particularly in urban or otherwise underresourced environments (Means, Penuel, & Padilla, 2001). Indeed, research indicates that the relatively simple act of helping teachers with their initial configuration of equipment, such as calibrating measurement equipment, can make a difference in their level of implementation of programs that goes beyond the routinely acknowledged contribution of well-designed professional development activities (Penuel & Means, 2004).

Limitations Associated with Modeling Approaches

The sources of data available for large-scale studies completed to date have also influenced the extent to which models of effective professional development can be expected to apply to specific program contexts. For example, although Garet et al. (2001) had conducted a survey of professional development providers, they relied solely on teacher-level data to construct their models. The technique they used—ordinary least-squares regression—was appropriate for the teacher survey dataset they used in their study and provided a path model with a readily interpretable visual diagram showing the strengths of particular relationships of features of professional development to changes in practice and knowledge. A subsequent analysis of longitudinal data from the same project did use hierarchical linear modeling to analyze effects (Desimone et al., 2002), but the analysis still used only data from teachers. Supovitz and Turner (2000) used an HLM model to investigate school-level effects separately from the contribution of individual teacher experience in professional development. However, for their school-level data they relied primarily on data from a survey of school leaders and collected data from teachers rather than from professional development providers on the design of their activities, even though these designs varied by provider rather than by teacher.

A further limitation to the accuracy of the models of effective professional development that have been analyzed so far is that neither of these two important studies had available data from a source other than teacher self-report about changes to teacher knowledge or practice. When teachers are asked about specific practices and the frequency with which they engage in them, there is often good agreement between teacher self-report and observations or regularly collected teacher logs (Mayer, 1999; Porter, Kirst, Osthoff, Smithson, & Schneider, 1993). However, within science education at least, teachers are increasingly aware of and biased favorably toward endorsing items that ask them about how much "inquiry-oriented" instruction they use, whether or not they in fact engage in those practices. Therefore, it is important to validate self-report data on instructional practice against direct observation or some other independent measure of practice.

Requirements for Studies Examining Aspects of Professional Development Associated with More Effective Curriculum Implementation

We agree with researchers who argue that most robust inferences about what makes professional development effective must come from experimental tests of different professional development designs that examine the impact on student achievement (Borko, 2004; Cohen, Raudenbush, & Ball, 2003). However, in addition to research on overall effectiveness of professional development in promoting student achievement, research is needed on the conditions required for effective *scaling* of programs, which requires different research designs and methods in which the focus is on predicting high-quality implementation of programs (Means & Penuel, 2005). Especially important are analytic methods that allow researchers and educational decisionmakers to understand how actions at different levels of the system (e.g., district, school, individual) can influence implementation and scaling processes.

Hierarchical linear models allow researchers to estimate the contribution of particular predictor variables when students and teachers are nested within particular conditions, such as different professional development experiences or in different school settings. Standardized coefficients from these analyses of effects of professional development on curriculum implementation provide a rough estimate of what kinds of professional development designs at the provider level and experiences at the teacher level may be necessary to achieve particular levels of scale with a program.

Ideally, there would be measures at each of the levels required for the study of program implementation. At the professional development provider level, data are needed about the design of the activities, specifically the extent to which they incorporate the kinds of features past studies have identified as potentially effective strategies, such as opportunities for teachers to spend time planning for classroom integration of materials into their instruction—

what is called “active learning” in the framework of Garet et al. (2001). In addition, some objective measure of program implementation at the teacher level tied to a model of implementation fidelity that can serve as an independent source of data on the effectiveness of professional development would be ideal. Observation data or automated records that document implementation provide potentially the most reliable data and could complement self-report data obtained through the kinds of surveys used in past studies. Survey questions should align as closely as possible with the implementation models of curricula in order to yield more program-specific information, as opposed to general information about teacher beliefs, knowledge, or instructional strategies.

Context for the Current Study

The GLOBE Program provides a context in which each of the important conditions described above can be met for studying what makes professional development effective in fostering curriculum implementation. The program exists at large scale (more than 33,000 teachers have been trained worldwide), and it has a well-specified model of implementation that calls for teachers to use protocols developed by scientists to engage students in authentic data collection activities, to report data to a Web site for use by students and scientists, and to structure student-led investigations using data collected for the program. At the same time, the program has a distributed model for providing professional development to teachers, and there is wide variation in levels of program implementation. Finally, in addition to survey data that can be collected from professional development providers and teachers, there is an accessible, independent measure of implementation—data reporting to a centralized Web site—that can be obtained for teachers who have received professional development from different partners.

GLOBE's Implementation Model

GLOBE's program design emphasizes both science and education. The Program provides curricular materials for use in classrooms, as well as an online database that is directed at supporting the work of scientists investigating aspects of the global environment. At the beginning of the Program, scientists funded as GLOBE Principal Investigators by the National Science Foundation developed a set of protocols for students to use in four distinct investigation areas related to Earth systems: Atmosphere, Hydrology, Soils, and Land Cover/Biology. GLOBE "schools," which include a small number of other kinds of organizations such as science museums and senior centers, collect the data according to the protocols.

The program expects GLOBE teachers to implement the protocols for the program, using specialized equipment that can be purchased directly by teachers or sometimes is made available by GLOBE's professional development providers. For example, Atmosphere protocols include collecting data on precipitation, maximum and minimum temperature, and cloud cover on a daily basis. To collect these data, students are expected to use GLOBE-certified equipment (available through major scientific equipment company catalogues) set up in a way specified by scientists in the program. Schools must set up an instrument shelter in a site that is in a grassy area, far from any potential shadows that could affect temperature readings. For other investigation areas, study sites also have special requirements and may need to be off the school property to accommodate scientists' specifications (e.g., at a stream to collect water quality data).

In addition to collecting data, the Program expects teachers to report data to the GLOBE Web site. Reporting data benefits scientists in the Program by making student-collected data available for their own investigations (see, e.g., Brooks & Mims, 2001; Mims, 1999). For students in classrooms, reporting data they have collected provides them with immediate access to charts and graphs of their data that the Web site produces; these charts and graphs in turn can be used as part of classroom discussions of patterns in their school's data and explanations for them. Past research on GLOBE's effects on students suggests that higher levels of student learning in GLOBE are associated with both more reporting and more frequent discussions of student-collected data (Coleman & Penuel, 2000; Penuel et al., 2002).

In the past 4 years, GLOBE has begun to encourage classrooms to pose questions using student-collected GLOBE data as part of extended, local investigations of Earth systems (The GLOBE Program, 2005). The visualizations of school-reported data, exemplars of student projects, rubrics for judging the quality of student research projects, available on the GLOBE Web site, as well as conferences highlighting student inquiry, are just a few examples of the kinds of resources GLOBE has made available to support inquiry in the classroom. Inquiry projects are expected to focus on student-generated questions tied to local issues or concerns, use and interpret GLOBE data, and communicate findings in a format typical of scientific research reports (e.g., with questions, hypotheses, methods, results, and discussion and conclusions sections). As part of its efforts to promote student inquiry, GLOBE has also provided its professional development partners with new formats for organizing workshops, organized the identification of Earth science questions that could be investigated at the local professional development site, and presented protocols and learning activities in such a way as to illustrate how these can be used to address these questions.

The GLOBE Program's Professional Development Activities

GLOBE has a distributed network of professional development partners. The rapid growth of the Program in its first 3 years of existence (1995-98) demonstrated the need for a different way to organize teacher preparation activities than the centralized, headquarter-administered training program GLOBE initially developed. To offer a broader network of support for teachers, headquarters staff instituted a program to engage officially designated regional GLOBE partners to recruit, develop, and support GLOBE teachers on a local level. The GLOBE Program has a small staff that functions as partner support at its headquarters, but the Program does not fund partners directly for their activities. Partners generate financial resources from a variety of sources, including federal grants, foundation grants, state and local education agencies, and their own institutions.

Although partners' professional development activities initially focused on training teachers to conduct protocols with students, in general their models of professional development have evolved to reflect the emerging consensus from research and practice about principles of effective professional development. Partners typically devote extensive time for teachers to plan classroom implementation and use active learning strategies in their initial training. In addition, a number of GLOBE partners have developed practices to support teachers in their classrooms after their initial training experience, such as helping them align GLOBE activities with local standards, modeling activities in the classroom, or helping with equipment setup (Penuel, Shear, Korbak, & Sparrow, 2005). Many schools and districts, for their part, have sent groups of teachers from schools to participate in professional development, sometimes as part of schoolwide strategies to encourage the implementation of GLOBE or inquiry-oriented instruction in their schools. Hence, the partners in this study offered professional development that reflects features of the most successful programs studied by researchers in the past (Garet et al., 2001; Supovitz & Turner, 2000).

At the same time, there are significant variations in what GLOBE's partners offer and what teachers experience. Limited funding of some partnerships, for example, makes it difficult for all to offer follow-up to teachers who participate. Some partners choose to modularize their initial protocol training sessions for teachers, teaching one protocol at a time. Some partners offer extensive opportunities within initial professional development activities for teachers to plan for curriculum integration; others offer just half an hour to an hour for this type of activity. This variability in offerings and experiences helps make GLOBE a good context for studying how particular features of professional development are associated with different implementation outcomes.

The GLOBE Data Archive

What makes GLOBE a particularly useful context for studying the effectiveness of professional development activities is the availability of an independent measure of program implementation for use by researchers. All data collected and reported by students for the GLOBE Program is stored a common database. The database, known as the GLOBE Data Archive, is available to anyone visiting the GLOBE Web site. Researchers can download the data easily to measure patterns in data reporting by investigation area and for any specified duration. In our study, we have used the Data Archive as a source of data on program implementation to complement survey data we obtained from teachers about their reported level of protocol implementation.

Methodology

The sources of data for the study were a survey of GLOBE partners (see Appendix D) in their capacity as professional development providers, a survey administered to GLOBE teachers (see Appendix E), and an independent measure of program implementation, GLOBE data reporting. The partner survey included items related to the design of professional development activities. The teacher survey included items used by Garet et al. (2001) to measure changes in teacher knowledge and teacher practice and measures to assess GLOBE implementation and information about equipment and support provided to teachers. Since the teachers in this study could be associated with particular partners as professional development providers, we conducted our analyses of these questions within a hierarchical linear modeling framework.

Sample

Our sample included 454 teachers who received initial GLOBE professional development and protocol training from 28 GLOBE partners within the past 2 years (2002-04). A median of 11 teachers were represented per GLOBE partner (ranging from 2 to 141 teachers per provider within the study population, though providers in general trained far greater numbers of teachers than those represented in our sample).

The 28 GLOBE partners were diverse geographically, as well as in the types of professional development offered to teachers. For example, the majority of partners used about six different types of active learning strategies as part of their initial protocol training, such as presenting examples or information on ways to integrate GLOBE with teachers' own curriculum or classroom activities (54% of providers), discussing the scientific significance of students' data collection activities (62% of providers), and discussing how datasets (GLOBE or other) can be used to illustrate mathematical concepts (38% of providers). The partners also provided, on average, five different types of activities that focus on student inquiry, such as discussing data from protocols to support student inquiry (51% of providers), offering examples of successful student inquiry projects (31% of providers), and showing teachers how to introduce GLOBE according to their students' knowledge and experience (31% of providers). Across the 28 partners, they offered, on average, 20 hours of professional development, ranging from 3 hours to 48 hours.

The teachers in our sample also had diverse backgrounds and experiences. While they all had in common the fact that they participated in initial GLOBE professional development, they varied in the types and amounts of additional professional development activities (in both traditional and reform-like forms) in which they participated. For example, 43% of teachers participated in reform-like professional development activities, such as participation in a teacher collaborative or network (14% of teachers); working with a mentor, coach, lead teacher, or observer (9% of teachers); or working in internships or immersion activities (1% of teachers), while 54% of teachers participated in traditional forms of professional development, such as in-district workshops (22% of teachers), out-of-district workshops (19% of teachers), or attendance at a college course (4% of teachers). Not all teachers implemented GLOBE, as measured by protocol use (48% of teachers) and GLOBE data reporting (27% of teachers). Further, on average, teachers took part in professional development that was spread over a 2-month span, with a range of less than 1 month to 2 years.

Procedures

GLOBE Partner Survey Development and Data Collection

In spring 2004, a GLOBE partner survey was developed that focused on current goals and practices of teacher professional development across GLOBE partners. Specifically, the survey asked about GLOBE partners' goals, the characteristics of their protocol training and qualifications of professional developers, practices for teacher support after professional development (including additional professional development provided to teachers), and the ways that they promoted student research and inquiry in GLOBE with the teachers in their partnership. We collected data from the GLOBE partners in July 2004 via a mailed questionnaire and online survey. Partners could either return their questionnaire using a postage-paid envelope or respond to the online survey.

GLOBE Teacher Survey Development and Data Collection

In winter 2005, a teacher survey was developed, adapting the questions that Garet et al. (2001) used in their original analysis of the features of effective professional development. In addition, we reused questions from past surveys of GLOBE teachers about aspects of GLOBE implementation and about contextual barriers and supports to implementation. Because the questions were all from earlier instruments, we did not feel the need for extensive pilot-testing of the items. However, to ensure that the order of the questions was sensible and that teachers were interpreting questions the way we intended them, we conducted face-to-face cognitive interviews (Desimone & Le Floch, 2004) with five teachers in the Midwest during the winter of 2005. Cognitive interviews are intended to improve the validity and reliability of surveys by finding out from potential respondents what their thought processes are when responding to particular items.

After the pilot test phase, the final teacher survey was mailed in March 2005 to a random sample of 1,467 teachers from the GLOBE Teacher Database who had been trained in 2002-03 or 2003-04.[3] A larger sample of teachers than needed for analysis was selected because a low response rate was expected. One reason to expect a low response rate was that the GLOBE database of teachers tends to have many inaccuracies due to changes in teachers' assignments from year to year and partners' differing levels of capacity for managing information on the teachers they serve. Second, past surveys have shown that teachers who are active in GLOBE, as measured by levels of data reporting, are much more likely to respond than are inactive teachers. In follow-up telephone calls, teachers who have been trained to implement GLOBE say that if they have not been implementing the program they feel embarrassed and are reluctant to complete surveys sent to them. Some teachers who do not implement GLOBE do respond to surveys, but the percentage is small.

The prediction of a low response rate was accurate: 454 teachers returned their surveys, for a response rate of 31%. A nonresponse bias analysis was conducted to determine whether there was systematic bias in the school settings of responding teachers. The GLOBE-trained teacher

[3] We initially randomly selected 1,800 teachers from the GLOBE database. However, because the database is not updated with current information, only 1,467 teachers had valid addresses and were currently teaching science.

database does not include demographic information; therefore, we merged extant data from the National Center for Education Statistics (NCES). This process resulted in having complete demographic information for 1,467 GLOBE teachers, 31% of whom completed the survey. For the survey results to be deemed reliable, it was necessary to demonstrate that the respondents reflected the larger population in terms of their distribution according to demographic variables such school size and proportions of low-income and minority students. Logistic regression was performed to determine whether the probability of survey completion was related to bias based on demographic factors. In addition, we analyzed whether there were differences in survey completion based on GLOBE data reporting.

The results showed no significant differences by school characteristics. This finding suggests that there was no systematic bias in respondents based on school size or on race/ethnicity or poverty levels of students. However, there were significant differences by GLOBE data reporting (OR = 2.03; CI = 1.51, 2.73). Of teachers who did not complete the survey, 81% did not report any GLOBE data; the remaining 19% reported some type of data (mean number of individual reports = 43). Of teachers who did complete the survey, 73% did not report GLOBE data, while 27% did report data (mean number of individual reports = 245).[4]

The characteristics of the respondents suggest that the results we report here may be valuable for estimating a kind of baseline for allocating professional development resources in such a way as to promote more widespread scaling of the program. It could be that more resources are needed for the broader population of surveyed teachers to promote better curriculum implementation, although our tests of models that include professional development design data but no teacher survey data suggest that the variables that are significant are in fact likely to be similar for the broader population of GLOBE-trained teachers included in our sampling frame.

GLOBE Data Archive

As described earlier, the GLOBE Data Archive contains information about GLOBE data reporting. As part of the GLOBE Program, teachers are required to report data on the GLOBE Web site. Hence, the GLOBE Data Archive provides objective data on teacher data reporting, a key aspect of GLOBE Program implementation. More specifically, the Data Archive stores a record for each day in which students collect data using any of the protocols. As teachers or students enter data on the Web, the data are verified by a program that checks the plausibility of the data or directly by scientists (for less-often implemented protocols). Some protocols call for data reporting at daily intervals; others require teachers to report on a monthly or even a one-time basis. We downloaded these data in summer 2005, and to account for variability in expected data reporting, we coded data reporting as a binary variable.

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[4] We ran further analyses to determine whether there were substantial differences between the survey respondents and the survey population of GLOBE teachers trained between 2002 and 2004 by the partners studied to whom we sent surveys. Specifically, we tested whether there were different effects of total data reporting, since these data are available for all teachers trained by particular partners. We conducted two hierarchical generalized linear models of total data reporting, one on the complete GLOBE teacher population (n = 1,467) and one from the GLOBE sample (n = 454). Both models produced similar results, suggesting that relationships found in the teacher sample may approximate those in the GLOBE population of teachers trained by the partners included as part of our study.

Measures

We relied on three sources of data: (1) Information about GLOBE professional development from the partner survey; (2) information about teacher knowledge, change, and continued professional development from the teacher survey; and (3) information about teacher data reporting, an indicator for GLOBE implementation, from the GLOBE Data Archive.

To determine whether to analyze measures at the teacher or partner level, we based decisions about what to include in Level 1 (teacher level) of our model and what to include in Level 2 (partner level) on where the variable was most likely to vary, regardless of whether the variable came from the partner or teacher survey. We used data from the partner survey about the design and features of the initial protocol training; however, we used data from the teacher survey about the duration of their professional development and perceived coherence of the activities with their school's and district's goals for student learning, since duration varied by teacher, depending on how many follow-up activities the teacher participated in, and perceptions of coherence could be expected to vary by teacher. Below, we describe each of the measures we used and the reasons for including each variable in the level we assigned it for purposes of analysis. Table 4-1 shows the descriptive statistics for the variables in the analyses.

Table 4-1. Descriptive Statistics for Teachers

	X	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total Data Reporting	0.27	0.45	1.00																
Protocol Use	0.48	0.50	0.22**	1.00															
Knowledge	0.01	0.99	0.00	0.34**	1.00														
Change	0.00	0.99	-0.04	0.10*	0.47**	1.00													
Inquiry	0.00	0.99	0.01	0.28**	0.68**	0.50**	1.00												
Barriers	6.84	4.48	-0.15**	0.05	-0.12*	-0.03	-0.04	1.00											
Equipment	0.50	0.50	0.21**	0.28**	0.16**	0.13**	0.14**	0.10*	1.00										
Technology Support	0.23	0.42	0.23**	0.28**	0.25**	0.16**	0.13**	-0.05	0.42**	1.00									
Reform PD	0.43	0.89	0.03	0.15**	0.27**	0.26**	0.23**	0.00	0.07	0.19**	1.00								
Traditional PD	0.54	0.81	0.02	0.15**	0.24**	0.19**	0.21**	0.15**	0.17**	0.13**	0.49**	1.00							
Time span	1.91	2.73	0.07	0.16**	0.24**	0.17**	0.22**	0.09	0.13**	0.18**	0.45**	0.43**	1.00						
Coherence	0.00	0.99	0.06	0.33**	0.66**	0.33**	0.54**	-0.17*	0.14**	0.18**	0.27**	0.27**	0.26**	1.00					
Collective Participation	0.25	0.48	-0.01	0.01	-0.05	0.08	-0.09	-0.03	0.08	0.09	0.00	0.01	-0.01	-0.12**	1.00				
Graduate degree	0.62	0.49	0.06	0.09	0.04	0.11*	0.03	0.23**	0.12*	0.08	0.07	0.10*	0.05	0.10*	-0.01	1.00			
Elementary school teacher	0.44	0.50	0.10*	0.11*	-0.05	0.02	-0.07	0.10*	0.15**	0.06	-0.01	-0.01	-0.02	-0.07	0.26**	0.07	1.00		
Middle school teacher	0.29	0.45	-0.06	0.14**	0.10*	0.01	0.04	0.12**	0.14**	0.07	0.13**	0.08	0.11*	0.14**	-0.12**	0.03	-0.31**	1.00	
High school teacher	0.18	0.38	-0.01	0.12*	0.13**	0.01	0.15**	0.09*	0.08	0.18**	0.18**	0.17**	0.13**	0.13**	-0.15**	0.12*	-0.31**	-0.09	1.00
Science Ed Certified	0.20	0.40	-0.07	0.07	0.02	0.03	0.05	0.08	0.01	0.01	0.06	0.07	0.01	0.08	-0.16**	0.10*	-0.36**	0.16**	0.32**

*Note: PD = Professional development. Teacher N = 454, * p < 0.05, ** p < 0.01.*

Dependent Variables (Level 1)

Using data from the teacher survey and the GLOBE Data Archive, five outcomes were measured. Three outcomes related to fidelity of program implementation: Protocol Use, Data Reporting, and Preparation for Student Inquiry. Two outcomes related to general changes associated with teacher professional development: Teacher Change in Practice and Knowledge of Pedagogy.

Data Reporting is a binary variable that measures whether teachers reported data on the GLOBE Web site. From the GLOBE Data Archive, the distribution ranged from no data reporting to 70,963 reports; the average number of data reports was 253.27. Because of the positive skewness of the distribution, a binary variable was created (1 = reported data; 0 = did not report data).

Protocol Use is a binary variable (1 = yes, 0 = no) showing whether teachers implemented the GLOBE protocols in their class. Teachers marked yes to conducting the protocols for Atmosphere, Hydrology, Biology, Soil, GPS, and Phenology. These variables were summed, but because of the skewness of the summed responses (most teachers reported conducting protocols for Atmosphere), a binary variable was created that measured whether teachers followed some type of GLOBE protocols.

Preparation for Student Inquiry is a 16-item factor (alpha = 0.94), measuring how much knowledge or confidence teachers had in inquiry-based activities, such as hands-on/laboratory activities, working on projects over a week or more, collecting environmental data in the field, and interpreting multiple representations of the same data. This is a continuous, normally distributed variable; the higher the number, the more teachers reported being prepared to engage in inquiry-based practices.

Teacher Change in Practice is a six-item factor (alpha = 0.84), measuring the extent to which teachers had made changes in their teaching practice. Adapted from the Garet et al. (2001) study, changes included types or mix of assessments used, ways technology is integrated into instruction, and instructional methods. This is a continuous, normally distributed variable; the higher the number, the more the teachers indicated that they changed their practice.

Knowledge of Pedagogy is a six-item factor (alpha = 0.91), measuring the extent to which teachers felt that their knowledge and skills had enhanced their curriculum, instructional methods, approaches to assessment, use of technology, teaching diverse students, and deepening knowledge of science. This is a continuous, normally distributed variable; the higher the number, the more teachers reported they had enhanced their knowledge. This variable was also adapted from the knowledge and skill variable of Garet et al. (2001).

Independent Variables: Teacher Level (Level 1)

We adapted some independent variables from prior work by Garet et al. (2001) and from past research on the GLOBE Program. They include both measures of characteristics of the professional development and factors that GLOBE evaluation research suggested might mediate the efficacy of the professional development activities. These variables are (1) Barriers,

(2) Equipment, (3) Technology Support, (4) Reform-like Professional Development, (5) Traditional Professional Development, (6) Time Span, (7) Coherence, and (8) Collective Participation. Teacher characteristic variables are: (1) Graduate degree, (2) Elementary, Middle, or High School teacher, and (3) Science Education Certification.

Some of these first four variables are arguably design features of the professional development that can be specified at the partner level (Level 2). Presumably, partners can set expectations about collective participation, and they could and did offer a mix of reform-like and traditional professional development over a specified time period. However, beyond initial protocol training provided by partners, teachers' experiences varied widely as to what follow-up activities they participated in with partners and other teachers. For instance, some partners reported offering mentoring on-site to teachers who requested it, but only some GLOBE teachers took advantage of that mentoring. Therefore, ratings about the availability of mentoring were analyzed as a teacher-level variable. Similarly, the time span of professional development experiences would have been longer for the teacher who received mentoring than for the one who did not, which informed our decision to make time span a teacher-level variable.

In addition to adapting the Garet et al. general professional development variables, we included GLOBE-specific variables. For example, the variable we call Barriers is an index of 10 items that asked about barriers in keeping teachers from implementing GLOBE with their students. Barriers included difficulty finding time to prepare, lack of technology access or support, difficulty identifying appropriate sites for taking GLOBE measurements, and changes in teaching assignments. This variable ranged from 0 to 20.[5]

Two variables measured professional development follow-up and support. Once teachers received their initial GLOBE professional development and protocol training, teachers indicated whether they received GLOBE-specific support, such as being provided with equipment and technology support. Equipment is a single survey item, which asked teachers whether they received GLOBE equipment from their GLOBE partner. This is a binary variable (0 = no, 1 = yes). Technology Support is a single survey item, which asked teachers whether the GLOBE partner provided assistance on technical setup and equipment use. This is a binary variable (0 = no, 1 = yes).

In the Garet et al. study, the type of professional development was a binary variable—teachers participated in either traditional or reform types of professional development. We believe that teachers can participate in multiple types of professional development in the same school year. Hence, we modified Garet's notion by including two continuous variables representing reform-like and traditional professional development. Reform-like Professional Development is an index of six types of professional development activities, such as participation in a teacher collaborative or network, working in internships or immersion activities, and working with a mentor, coach, or lead teacher. The variable ranged from 0 to 5. Traditional Professional Development is an index of four types of professional development activities, such as participation in an in-district workshop and attendance at a college course, out-of district workshop, and/or out-of-district conference. The variable ranged from 0 to 4.

[5] Each item was on a three-point scale: 0 = Not a barrier, 1 = Minor barrier, 2 = Major barrier.

Similar to the Garet et al. study, Time Span is an index, ranging from 0 to 24 months, which measures how many months teachers participated in preliminary or formal follow-up professional development sessions.

Similar to the Garet et al. study, Coherence is a six-item factor (alpha = 0.86), which measures how well the professional development matched the teacher's goals for professional development, the existing reform ideas within the school, and whether the professional development was followed up with activities that built on what had already been learned. As a continuous, normally distributed variable, the higher the number, the more teachers indicated that their professional development was consistent with their own needs.

Similar to the Garet et al. (2001) study, Collective Participation is an index of two survey items: participants in the professional development consisted of all teachers in the department or grade groupings or of all teachers in the school or set of schools. The variable ranged from 0 to 2.

Teacher characteristics included whether they had a graduate degree (master's level or above), the grade level they taught (elementary, middle, or high school), and whether they had a science education teacher certification.

Independent Variables: Partner Level (Level 2)

Six variables were used to measure professional development context: (1) Planning for Implementation; (2) Focus on Student Inquiry; (3) GLOBE Content; (4) Total Hours of Initial Protocol Training Offered; (5) University Sponsored; and (6) School District Sponsored. Table 4-2 shows the descriptive statistics and correlations of the partner-level variables described.

Table 4-2. Descriptive Statistics for Partners

	X	SD	1	2	3	4	5	6
Planning for Implementation	6.93	4.18	1.00					
Focus on Inquiry	5.79	4.65	0.53**	1.00				
GLOBE Content	0.17	1.00	0.46*	0.36	1.00			
Total Hours Training	21.61	13.97	0.41*	0.48**	0.71**	1.00		
University Sponsored	0.43	0.50	0.02	-0.07	0.16	0.26	1.00	
District Sponsored	0.11	0.31	-0.02	-0.03	0.13	-0.02	-0.30	1.00
Other Sponsored	0.33	0.48	0.00	0.09	-0.24	-0.24	-0.81**	-0.32

*Note: Partner N = 28. * $p < 0.05$, ** $p < .01$.*

Adapted from the Garet et al. (2001) study, Planning for Implementation is an index of 12 instructional approaches, such as discussing alignment of GLOBE with state, regional, or national standards; engaging teachers in aligning GLOBE activities with standards and how they might integrate GLOBE with their own curriculum and classroom activities; and presenting tips on ways to tailor GLOBE to students' needs. The Planning variable is a continuous variable from 0 to 12; the higher the number, the more the partner helped teachers make linkages between the professional development and their local contexts, such as standards and schedules.

Focus on Student Inquiry is an index of 13 instructional approaches to supporting the goal of student inquiry, such as discussing how data from protocols can be used to support student inquiry, offering examples of successful student inquiry, engaging teachers in an inquiry activity during their initial protocol training, and modeling specific steps of using scientific inquiry in the classroom during that training. Focus on Student Inquiry is a continuous variable from 0 to 13; the higher the number, the more inquiry-based the initial professional development.

Because this study focused on science, our measure of content knowledge, unlike the Garet et al. (2001) general variable of content knowledge, is science and GLOBE specific. GLOBE Content is a nine-item factor (alpha = 0.92), measuring how much time teachers devoted to GLOBE content during their initial protocol training in areas such as Atmosphere, Hydrology, and Biology protocols and learning activities. The factor is standardized and is a continuous variable; the higher the number, the more GLOBE content was offered during professional development.

The variable Total Hours of Initial Protocol Training offered to teachers is a composite of two questions and is adapted from the Garet et al. study. The first question asked whether a typical professional development program was offered in a single session and, if so, how many hours. The second question asked whether a typical professional development program was offered in multiple sessions and, if so, how many days and how many hours per day.

Similar to the Garet et al. study, we also included the professional development sponsor. Specifically, each partner was sponsored by either a university, school district, or other organizations, such as science museums. Dummy variables were created to stand for university or school district sponsorship (as opposed to other sponsors).

Analysis Plan

Descriptive statistics and correlations were conducted on all items, factors, and indices created for the analysis. Standard quality control of the data was conducted, such as checking for multicollinearity, skewness, and variance.

In the current study, we have two levels of data: the teacher level, which includes additional professional development activities, perceptions of coherence, and barriers, and the partner level, which includes information regarding the types of professional development teachers received. Because of the nested structure of the dataset, we used hierarchical linear modeling to examine teacher professional development experiences (Level 1) and the professional development context that the partners offered (Level 2).

For each outcome variable, we first conducted an unconditional model to determine whether there was adequate variance to explain at the teacher and partner levels of the model. There was significance in the Level 2 variance for the outcome variables, ranging from 3% to 5%. We then proceeded to conduct conditional models as specified below:

Level 1: Teacher

$$
\begin{aligned}
Y_{ij} = {} & \beta_{0j} + \beta_{1j}(\text{BARRIERS}) + \beta_{2j}(\text{EQUIPMENT}) + \beta_{3j}(\text{TECHNICAL HELP}) + \\
& \beta_{4j}(\text{REFORM PD}) + \beta_{5j}(\text{TRADITIONAL PD}) + \beta_{6j}(\text{TIMESPAN}) + \beta_{7j}(\text{COHERENCE}) + \\
& \beta_{8j}(\text{COLLECTIVE PARTICIPATION}) + \beta_{9j}(\text{GRADUATE DEGREE}) + \beta_{10j}(\text{ELEMENTARY}) + \\
& \beta_{11j}(\text{MIDDLE}) + \beta_{12j}(\text{SCIENCE ED CERTIFICATION}) + r_{ij}
\end{aligned}
$$

Level 2: Partner

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{PLANNING})_j + \gamma_{02}(\text{FOCUS ON STUDENT INQUIRY})_j + \gamma_{03}(\text{GLOBE CONTENT})_j + \gamma_{04}(\text{TOTAL HOURS})_j + \gamma_{05}(\text{UNIVERSITY})_j\ \gamma_{06}(\text{DISTRICT})_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$
$$\beta_{5j} = \gamma_{50}$$
$$\beta_{6j} = \gamma_{60}$$
$$\beta_{7j} = \gamma_{70}$$
$$\beta_{8j} = \gamma_{70}$$
$$\beta_{9j} = \gamma_{70}$$
$$\beta_{10j} = \gamma_{70}$$
$$\beta_{11j} = \gamma_{70}$$
$$\beta_{12j} = \gamma_{70}$$

For the binary outcome variables (Data Reporting and Protocol Use), a similar model was used, but for a Bernoulli distribution with a log-link function (Raudenbush, Bryk, Cheong, & Congdon, 2000; Raudenbush & Bryk, 2002).

Results

Impact of Professional Development on Program Implementation

To address the first research question, "What kinds of professional development activities in GLOBE are associated with increased levels of program implementation?" Table 4-3 shows the results for the kinds of professional development activities in GLOBE associated with increased levels of program implementation, as measured by total data reporting, protocol use, and preparedness for student inquiry. The kinds of initial professional development activities offered by the GLOBE partners had a significant impact on GLOBE implementation. First, we found that when partners provided professional development focused on GLOBE implementation, such as discussing alignment of GLOBE with state, regional, or national standards, engaging teachers in aligning GLOBE activities with standards and how they might integrate GLOBE with their own curriculum and classroom activities, teachers were more likely to feel prepared for student inquiry (β = 0.03; s.e. = 0.01; t-ratio = 2.72) and have higher levels of GLOBE protocol use (β = 0.12; OR = 1.13; CI = 1.04, 1.22). This is similar to the Garet et al. (2001) study, in which the researchers found that teacher perceptions of support for planning had a positive impact on teacher learning.

Second, total hours of professional development provided by partners also mattered in whether teachers used the GLOBE protocols with students and felt prepared for student inquiry. Interestingly, in both cases, there was a negative relationship between total hours of professional development and teachers' preparedness for student inquiry (β = -0.01; s.e. = 0.00; t-ratio = 3.01) and their use of GLOBE scientific protocols (β = -0.05; OR = 0.96; CI = 0.93, 0.98).

Third, GLOBE content emphasized during the initial professional development had a significant positive relationship to teachers' preparedness for student inquiry (β = 0.17; s.e. = 0.05; t-ratio = 3.06).

Fourth, partners who had a greater focus on student inquiry and the scientific process had a significant positive relationship to teachers' data reporting practices (β = 0.21; OR = 1.23; CI = 1.06, 1.42).

The kinds of additional professional development teachers had after the initial professional development was also important for GLOBE implementation. First, the importance of teachers' having meaningful, ongoing, and coherent professional development experiences that were consistent with their local school and district goals and other ongoing reform efforts was significant for teachers' protocol use (β = 0.63; OR = 1.87; CI = 1.45, 2.41) and preparedness for student inquiry (β = 0.51; s.e. = 0.04; t-ratio = 13.02). Consistent with the Garet et al. (2001) findings, perceived coherence of teacher professional development has a positive impact on GLOBE Program implementation. Second, teachers who had more reform-like professional development were more likely to report feeling prepared for student inquiry (β = 0.10; s.e. = 0.04; t-ratio = 2.80).

Impact of Professional Development on Teacher Knowledge and Change

For the second research question, "What kinds of professional development activities in GLOBE are associated with increased teacher knowledge and changes to science teaching practice?"

Table 4-4 shows the results for the kinds of professional development activities in GLOBE associated with increased teacher knowledge and changes to science teaching practice. For teacher knowledge and change, coefficients related to initial professional development from the GLOBE partners were not significant.

However, additional professional development that teachers had after the initial session(s) had a significant impact on teacher knowledge and change. First, consistent with the Garet et al. study, coherence was a significant positive predictor for teacher change ($\beta = 0.28$; s.e. = 0.05; t-ratio = 5.90) and knowledge of pedagogy ($\beta = 0.59$; s.e. = 0.05; t-ratio = 10.95). Second, teachers reported more change when there was collective participation in their professional development ($\beta = 0.17$; s.e. = 0.06; t-ratio = 2.95). Third, reform-like professional development experiences had a positive impact on teacher change ($\beta = 0.17$; s.e. = 0.06; t-ratio = 2.85).

Impact of Support after Professional Development

Pertaining to the third research question, "How do support and follow-up after professional development influence program implementation and teacher knowledge and changes to science teaching practice?" GLOBE equipment and technology support had significant influences on program implementation (GLOBE data reporting and protocol use), teacher knowledge, and changes to science teaching practice. Not surprisingly, being provided with GLOBE equipment was important for total data reporting ($\beta = 0.69$; OR = 1.99; CI = 1.21, 3.28) and protocol use ($\beta = 0.62$; OR = 1.87; CI = 1.16, 3.01). Having follow-up technology support was important for teacher knowledge ($\beta = 0.24$; s.e. = 0.10; t-ratio = 2.46), total data reporting ($\beta = 0.90$; OR = 2.45; CI = 1.35, 4.46), and protocol use ($\beta = 0.88$; OR = 2.40; CI = 1.28, 4.52).

Table 4-3. Impact of Professional Development on Program Implementation

	Total Data Reporting		Protocol Use		Preparedness for Student Inquiry	
	Odds Ratio	**95% CI**	**Odds Ratio**	**95% CI**	**β**	**s.e.**
Intercept, γ_{00}	0.200***	0.123, 0.325	0.983	0.749, 1.291	-0.056	0.034
Planning for Implementation, γ_{01}	1.036	0.904, 1.188	1.128**	1.041, 1.221	0.032*	0.012
Focus on Student Inquiry, γ_{02}	1.228**	1.060, 1.422	1.008	0.930, 1.092	0.007	0.010
GLOBE Content, γ_{03}	0.625	0.341, 1.146	1.212	0.881, 1.668	0.165**	0.054
Total Hours of Training, γ_{04}	0.975	0.924, 1.028	0.955**	0.931, 0.980	-0.012**	0.004
University Sponsored, γ_{05}	1.712	0.724, 4.049	1.655*	1.033, 2.652	-0.071	0.089
School District Sponsored, γ_{06}	1.027	0.321, 3.291	1.281	0.456, 3.594	-0.228*	0.085
Barriers, γ_{10}	0.896**	0.829, 0.969	1.029	0.976, 1.085	0.013~	0.007
Equipment, γ_{20}	1.994**	1.213, 3.278	1.866**	1.157, 3.008	0.129	0.092
Technology Support, γ_{30}	2.450**	1.346, 4.460	2.401**	1.275, 4.524	0.016	0.090
Reform-like PD, γ_{40}	1.037	0.784, 1.371	1.007	0.723, 1.404	0.098**	0.035
Traditional PD, γ_{50}	0.966	0.774, 1.206	1.092	0.836, 1.425	0.002	0.052
Time Span of PD, γ_{60}	1.025	0.964, 1.090	1.050	0.975, 1.130	0.015	0.015
Coherence, γ_{70}	0.867	0.702, 1.071	1.869***	1.449, 2.412	0.506***	0.039
Collective Participation, γ_{80}	0.670	0.405, 1.109	1.264	0.811, 1.969	-0.038	0.057
Graduate Degree, γ_{90}	1.508~	0.980, 2.322	1.162	0.754, 1.789	-0.075	0.085
Elementary School Teacher, γ_{100}	1.299	0.782, 2.160	2.918***	1.628, 5.230	-0.120	0.118
Middle School Teacher, γ_{110}	0.724~	0.496, 1.057	1.966*	1.096, 3.528	-0.166~	0.094
Science Ed Certification, γ_{120}	0.605	0.224, 1.633	1.421	0.817, 2.471	-0.011	0.102

*Note: There were 454 teachers in 28 partnerships. ~ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Table 4-4. Impact of Professional Development on Teacher Change and Knowledge

	Teacher Change		Teacher Knowledge	
	β	**s.e.**	**β**	**s.e.**
Intercept, γ_{00}	-0.081	0.054	0.045	0.054
Planning for Implementation, γ_{01}	0.014	0.016	0.024	0.014
Focus on Student Inquiry, γ_{02}	0.001	0.013	-0.009	0.014
GLOBE Content, γ_{03}	0.036	0.071	0.055	0.076
Total Hours of Training, γ_{04}	-0.001	0.005	-0.007	0.006
University Sponsored, γ_{05}	-0.177	0.136	0.027	0.112
School District Sponsored, γ_{06}	-0.308***	0.074	-0.070	0.098
Barriers, γ_{10}	0.001	0.009	-0.001	0.007
Equipment, γ_{20}	0.062	0.085	0.096	0.060
Technology Support, γ_{30}	0.137	0.140	0.240*	0.098
Reform-like PD, γ_{40}	0.173**	0.061	0.043	0.046
Traditional PD, γ_{50}	0.017	0.058	0.044	0.045
Time Span of PD, γ_{60}	-0.001	0.015	0.014	0.016
Coherence, γ_{70}	0.281***	0.048	0.593***	0.054
Collective Participation, γ_{80}	0.165**	0.056	0.089	0.118
Graduate Degree, γ_{90}	0.104	0.071	-0.042	0.063
Elementary School Teacher, γ_{100}	-0.022	0.137	-0.010	0.088
Middle School Teacher, γ_{110}	-0.095	0.099	-0.031	0.091
Science Ed Certification, γ_{120}	0.072	0.110	-0.117	0.108

*Note: There were 454 teachers in 28 partnerships. ~ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Discussion and Conclusions

Our results indicate that the design elements of professional development that mattered most for program implementation in GLOBE varied, depending on the aspect of implementation being measured. To increase data reporting, the most effective professional development strategy was to focus on promoting student inquiry in initial professional development sessions. In other words, a unit increase in Focus on Student Inquiry increased the odds of data reporting to by 23%. For both protocol use and preparedness for student inquiry, the opportunity to "localize" GLOBE—that is, to plan for how to tailor its implementation to local circumstances of teachers' classrooms—was a significant predictor of the extent to which teachers implemented these aspects of the program. In addition, a focus on the content of GLOBE was a significant predictor of teachers' feeling more prepared to implement student inquiry in GLOBE. We found conflicting results for the effect of duration of professional development and for the nature of the GLOBE partner providing the professional development: more hours of professional development supported greater protocol use but seemed to undercut a focus on student inquiry, and university-based partners tended to do a better job supporting protocol use, while reliance on school-based partners was associated with less frequent use of student inquiry.

Some aspects of the program design itself are likely to contribute to this pattern of findings. For example, to engage in student inquiry, an initial hurdle teachers must overcome is the tendency to collect but not report data because of time constraints. Reporting data, however, makes it possible for students and teachers to discuss and analyze data because the GLOBE Web site can quickly produce charts and graphs of schools' data. Initial professional development that focuses on inquiry may have made teachers much more likely to report data, even if they did not feel any more prepared to implement student inquiry with GLOBE in their classrooms. The fact that giving teachers time to plan for implementation and a focus on GLOBE content did help teachers with feeling more prepared to facilitate student inquiry is also not surprising; GLOBE's training of partners in how to support teachers in inquiry emphasizes the need to tailor the content to local questions of scientific interest that can be investigated by using GLOBE protocols and to local standards. Providing teachers with time to consider the links between GLOBE content and local questions and learning goals consequently appears to have helped them be better prepared to facilitate student inquiry.

Another set of activities partners typically undertake as part of the program design but that are not part of the formal professional development also consistently predicted curriculum implementation. Providing GLOBE equipment and support for setting up that equipment predicted both protocol use and data reporting. Again, aspects of the program design itself can help to explain these findings, which are consistent with earlier findings about supports necessary for program implementation in GLOBE and other programs (Blumenfeld, Fishman, Krajcik, Marx, & Soloway, 2000; Fishman & Krajcik, 2003; Penuel & Means, 2004). At the same time, our findings suggest that although providing specialized equipment and support for using it may not be a professional development activity *per se*, these activities are likely to improve the efficacy of those activities in fostering curriculum implementation and are thus important to examine when trying to determine the impact of the professional development.

At the teacher level, perceived coherence of the professional development activities with teachers' own districts' goals for student learning and with their goals for professional development was a strong predictor of two aspects of curriculum implementation in GLOBE: protocol use and preparation for student inquiry. These effects suggest that teachers' interpretations of professional development activities, not just the design of the activities themselves, are important in shaping the effectiveness of those activities, as both the earlier Eisenhower study (Garet et al., 2001) and other scholars who have studied teachers' interpretations of reform efforts have found (Spillane & Jennings, 1997). At the same time, the significance of this finding should be interpreted with caution, since it is impossible from our data to know whether teachers' judgments of the professional development's coherence were made before they had begun to implement the program; an alternative explanation would be that teachers formed these judgments after an initial implementation of the program. Interestingly, the second analysis of the Eisenhower study that relied on longitudinal data (Desimone et al., 2002) did not find such a strong effect for coherence, suggesting that although it is accurate to say judgments of coherence and program implementation may be related, the direction of influence may not be so clear.

Interestingly, when we examined correlations among our variables and predictors of outcome variables that the earlier Eisenhower studies examined in their analysis—changes to teacher knowledge and practice—our pattern of findings was largely consistent with these earlier results. Like the earlier studies, in our HLM analyses we found that the sponsor of the professional development, the use of "reform-like" professional development activities, perceived coherence, and collective participation predicted these outcomes. Furthermore, correlations among partner-level variables showed significant associations between a focus on content and use of what we are calling "support for planning" but that Garet et al. (2001) referred to as "active learning strategies." Among variables at the teacher level, consistent with the earlier studies, we found significant correlations among independent variables: between professional development type and time span and between type and coherence. We also found significant correlations between type of activity, time span, and coherence on the one hand and changes in knowledge and practice on the other, just as the earlier studies did.

Taken together, the pattern of findings from our study suggests that the emerging research on what makes for effective professional development in science education considered broadly does provide a useful framework for examining what makes professional development for specific curricular programs, but that the particular aspects of individual programs can make some features more or less important for supporting implementation. In GLOBE, giving teachers time to plan for implementation was important for helping teachers integrate the materials into their curriculum and develop ways to promote student inquiry through the program's activities and materials, and providing the specialized equipment needed to collect data was critical to the eventual impact of the professional development on practice, even if it was not part of the professional development itself. In other programs, the configuration of demands on teachers and adaptability to local context might be different, and we would expect that for professional development to be effective, it would need to be better tailored both to the program and to the local context.

When considering how to "localize" their professional development activities, providers thus need to consider not only teachers' own contexts but also the program's demands on teachers and how those demands can be met within their contexts. Essentially, as others have argued regarding the elements necessary for the scaling of educational innovations in science, there must be a good “fit” between the curriculum and the local context, and our findings suggest that fit is shaped partly by the effectiveness of the professional development activities themselves but also by the ability of providers to meet other demands of teachers and by teachers’ own judgments about how coherent a program is with their personal professional goals and their goals for their students’ learning.

Study Limitations and Future Directions

Because we did not use a random assignment design or seek to control any partners' approach to professional development, our study cannot speak directly to the impact of professional development on teacher practice or on student learning. We agree with policymakers who argue that such studies are needed, and we also believe that the ultimate measure of success for any educational reform or professional development program is whether it leads to improvements in students' learning (Fishman et al., 2003). However, creating a chain of evidence that links student learning to teacher learning, professional development, and policy is remarkably challenging; and so far, most studies, including this one, have elected to look at components of this chain (Loucks-Horsley & Matsumoto, 1999). Future studies need to be constructed to explore multiple elements at the same time, but doing so may require an even narrower focus on implementation of particular innovations.

Further, our study's data preclude us from saying that ours is a representative sample of GLOBE teachers' experiences. Our missing-data analysis indicated that the sample consisted of teachers from schools that were much more likely to be implementing GLOBE than the general population of GLOBE schools. Our study, therefore, cannot give us precise estimates needed to determine the amount of time and professional development resources required to achieve a particular level of scaling with all GLOBE-trained teachers. However, we do believe that the models suggest the kinds of professional development resources that are essential to achieve scaling, including some kinds of resources (especially equipment and support for setting up equipment) that are not always considered as part of professional development activities. Further, some aspects of professional development, especially perceived coherence, that proved significant suggest that further research is needed into how teachers make such judgments and how they relate to influential policies and practices in teachers' district and school contexts.

CHAPTER 5

GLOBE ONE: LESSONS FOR STUDENT-SCIENTIST PARTNERSHIPS

Researchers, policymakers, and advocates of reform in science education have sought ways to bring students closer to the world of scientists. The *National Science Education Standards* (National Research Council, 1996, p. 79; 2000), for example, emphasize that science instruction should prepare students with fundamental understandings of and abilities for conducting scientific inquiry by engaging them in planning and carrying out their own investigations. Other investigators have sought to develop curricular materials and models for classroom discussion aimed at helping students develop specific inquiry skills, such as formulating questions (Penuel, Yarnall, Koch, & Roschelle, 2004), developing representations of data (Suthers & Hundhausen, 2003), and developing explanations from analyses of data (Bell, 2002; Sandoval & Reiser, 2004).

Student-scientist partnerships (SSPs) represent yet another strategy that has been developed to bring students closer to the work of scientists by allowing for direct and sustained contact between students and scientists (Cohen, 1997). These partnerships typically have one or more goals for both students and scientists. In addition to providing students with opportunities to see scientists at work, such partnerships may aim to provide them with a hands-on experience of participating in science or with an opportunity to participate in community service. Scientists, for their part, may be involved as part of their own interest in or commitment to educational outreach, or they may become involved in SSPs to advance their own research agendas.

The GLOBE Program represents a particularly ambitious kind of student-scientist partnership, in that from the beginning its mission was to be both a science and education program with sustained involvement of teachers, students, and scientists over multiple years. As a science program, GLOBE has sought to rely on student-collected data to advance scientific understandings of the Earth as a system; scientists have been funded to participate both to achieve educational outreach goals and to analyze GLOBE data for scientific publications. As an education program, GLOBE seeks to enhance students' environmental awareness, knowledge of science, and understandings of science inquiry through participation in data collection, reporting, and analysis activities and engaging with materials from the Teacher's Guide. What makes GLOBE unusual among SSPs is its commitment to *sustained involvement* of scientists through multiyear grants and of students and schools through ongoing support to teachers. By contrast, other SSPs in the past have been of more limited duration and sought to limit the commitments required of both scientists and schools (Spencer, Huczek, & Muir, 1998; Trumbull, Bonney, Bascom, & Cabral, 2000).

Beginning in 2003, however, the GLOBE Program began experimenting with a new model for its SSPs by developing GLOBE ONE, a field campaign that brought together several NSF-funded GLOBE scientists with students and teachers in schools in northeastern Iowa that had been relatively active within the Program. In the field campaign, the science goals were initially to be given priority, with an emphasis on conducting research that would yield publications in peer-reviewed science journals. Moreover, the expected duration of schools' involvement would be limited, not indefinite. To support the science, students would be expected to collect data following specific protocols, and only for the duration of the campaign. The local educational partner coordinator supporting GLOBE ONE, Marcy Seavey, was to serve as a liaison to the schools and help ensure that teachers' and students' participation was meaningful and linked to district standards, but the design of GLOBE ONE was initially focused on ensuring that scientists, not students, benefited most from the project.

As we argue in the case study presented in this chapter, education goals reemerged over time as coequal with science goals within GLOBE ONE, and the evidence of the success of the campaign is much clearer with respect to education goals than for science goals. Changing the expectations for teachers and students in Globe ONE brought GLOBE more in line with other successful SSPs, and direct encounters with scientists facilitated through the project motivated students' involvement, resulting in increased GLOBE activity in participating schools and new student investigations that used GLOBE data. By contrast, the need to bring multiple scientists to a single area where student activity in GLOBE was high but where no individual scientist had a strong understanding of local environmental dynamics made it difficult for the scientists to settle on a research question. Further, the time frames required to analyze data generated from the project and generate publications were longer than the time allotted for the project; to date, scientists agree that the project's success in meeting its science goals is yet to be determined.

In this chapter, we review what other researchers have found about successful SSPs, describe the unfolding of GLOBE ONE as a project and the increasing importance given to education goals over time, and present evidence for the claim that GLOBE ONE reveals a central and inherent challenge in fostering SSPs, namely, determining an appropriate balance of science and education goals such that both kinds of goals can be met within the same partnership.

Prior Research on Student-Scientist Partnerships

Research on student-scientist partnerships has examined two primary issues: (1) benefits of participation to students and scientists and (2) features of effective SSPs. Research on the benefits of participation has tended to focus much more on benefits to students than on benefits to scientists, and research on features of effective SSPs has focused both on challenges to implementation and on conditions believed to be necessary for SSPs to succeed in meeting both schools' and scientists' goals for participation.

Reported Benefits of SSPs for Students and Scientists

For educators, a key motivating feature for participation in SSPs is the contact with scientists and scientific projects (Means, 1998; Murphy, 1998). SSPs provide valuable authentic learning opportunities because the contact with scientists provides motivation for learning science and pursuing science careers. Visits from scientists can be motivating for teachers as well as for students, as both see the importance of their own work and how it contributes to scientists' projects. In an SSP focused on monitoring air quality, for example, scientists visited schools before and after the project, and their visits had the effect of getting teachers and students excited about doing "current scientific research on a topic which had significance to them" (Murphy, 1998, p. 113). Another example is the *Aquanaut Program*, where research scientists meet with teachers and involve them in all parts of research projects in oceanic science, including data collection and analysis (Babb, Scheifele, & Tedeschi, 1997). Evaluations of the *Aquanaut Program* revealed that not only were teachers and students motivated by scientists to participate in scientific projects, but many students also went on to attend college and pursue science careers. In a sample of more than half the program's 855 alumni, 70% of those in college said the program had "directly and positively affected their choice to pursue a career in the sciences, engineering, or mathematics" (Babb et al., 1997, p. 79).

In addition to motivating interest in science as a topic and a career, an important argument for the educational value of SSPs is that they can provide opportunities for students to learn science more effectively in authentic settings (Barab, Squire, & Dueber, 2000; Lawless & Rock, 1998; Rahm, Miller, Hartley, & Moore, 2003; Richmond & Kurth, 1999). Supporters argue that science learning in the traditional didactic science classroom cannot be authentic, since the activities students do only simulate what scientists do and students gain little more than a rudimentary, fact-based understanding of the nature of science. Students need to engage in real science activities, where they do activities that allow for more authentic learning to happen through the interaction with scientists and their projects (Barab et al., 2000; Lawless & Rock, 1998; Rahm et al., 2003; Richmond & Kurth, 1999). Barab and Hay (2001) note that the value of SSPs lies in that students do authentic science "at the elbows" of experts, learning from the process of doing science and being taught and explained to in context, rather than through direct teaching of science facts. By doing science at the elbows of scientists, students and teachers learn about the content and process of science while they come to participate in a variety of studies of scientific phenomena (Barab & Hay, 2001; Tinker, 1997). Most important, participation that is embedded "in ongoing activity within the ecological niche in which the real-world practitioner functions" (Barab et al., 2000, p. 40) will result in a sense of authenticity that is in synchrony with the science of the scientists.

Learning to think with data, to hypothesize and draw conclusions, is another important science skill that SSPs support (Feldman, Konold, & Coulter, 2000; Kreuger, French, & Carter, 1997). Teaching students to be literate users of data, as well as literate in scientific concepts more generally, is widely recognized as essential to educating an informed citizenry (Trumbull et al., 2000). When students gather data in programs like GLOBE and then learn to think about those data as they engage in inquiry projects, they are practicing skills that will translate to better data analysis skills as adults.

With respect to benefits to scientists, much less has been explored within SSPs; what has been written focuses on partnerships' ability to support data collection and to meet goals for education outreach. For example, scientists view the ability of students to collect data at schools as being useful in validating satellite measurements of environmental phenomena (Finarelli, 1998) or pollution monitors of air quality (Murphy, 1998), as well as accessing data from wide areas that otherwise would not be available—for example, in forests (Fougere, 1998). Scientists may also partner with students to look at existing datasets that are unusually large, as in NASA's Mars SSP, where students are helping scientists search for evidence of ancient life on Mars by examining data from the Mars Pathfinder (Barstow & Diarra, 1997). Donahue and colleagues (Donahue, Lewis, Price, & Schmidt, 1998) found that "Scientists who are involved in successful SSPs become personally engaged in the educational process. They spend time, share perspectives, and conduct the real business of scientific research side-by-side with students" (p. 21).

Challenges and Critical Design Features for SSPs

Researchers have also documented many challenges in making SSPs successful, and chief among them is balancing goals for education and science (Means, 1998; Mims, 1997; Morse & Sabelli, 1997). For example, although scientists may need ongoing, consistent data for their investigations, teachers do not always view collecting and reporting data as educationally valuable activities in their own right (Means, 1998; Penuel & Means, 2004). Further, evaluations of the GLOBE Program have consistently found that even when teachers value these activities, they find it difficult to find time to implement them on the schedule that scientists require (Means, Coleman, & Lewis, 1998; Means et al., 2000; Means et al., 2001).

A number of SSPs have sought to develop strategies for addressing these concerns. One strategy used is to structure time for scientists and educators to get to know one another and to learn about one another's goals for participation (Spencer et al., 1998). Another successful strategy has been to develop SSPs around focused, time-limited campaigns for clearly understood purposes (Trumbull et al., 2000). Many successful projects described in the research on SSPs are focused campaigns, or ongoing projects that have seasonal or occasional focused campaigns, such as a 2-week science apprenticeship camp (Barab & Hay, 2001). Other examples are *Boreal Forest Watch*, where observations take place on an annual or semiannual basis (Spencer et al., 1998). and *EarthWatch*, where teachers and students go on trips that last about 2 weeks (Nixon, 1997). Even *Journey North* (Feldman et al., 2000), which is an ongoing project, conducts seasonal campaigns that are more focused in nature and easier for teachers to fit into their curriculum. In short, focused campaigns allow scientists to get the data they need, while being a manageable way for teachers to meet education goals.

Another significant challenge to SSPs is that teachers and students in SSPs may require extensive support to carry out inquiry-related activities in their classrooms (Krajcik, Blumenfeld, Marx, & Soloway, 1994; National Research Council, 2000; Singer, Krajcik, Marx, & Clay-Chambers, 2000; White & Frederiksen, 1998). Teachers need materials, strategies, and images of inquiry-based teaching to enact it successfully in the classroom (National Research Council, 2000). For their part, students often need help from teachers in constructing representations of data (Lehrer & Schauble, 2002), reasoning with and about data (Hancock, Kaput, & Goldsmith, 1992), and formulating explanations for patterns in data (Sandoval & Reiser, 2004). Past studies of SSPs in particular have pointed out that students have difficulty with the concept of asking questions of data or using data to answer a question a scientist might have (Feldman et al., 2000).

Specific SSPs have developed inquiry materials and professional development experiences to support different aspects of the inquiry process. For example, *Journey North* includes online materials for teachers to help students develop their own research questions and analyze data. The GLOBE Program has sought over the years to develop similar kinds of materials; a CD-ROM resource developed in 2002 aimed at preparing students for inquiry, and new training and professional development modules all emphasize student inquiry (Penuel, Fishman, & Yamaguchi, in preparation; Penuel et al., 2002). Although learning sciences researchers have developed such scaffolds for other materials with evidence of success (e.g., Suthers & Hundhausen, 2003), little is known about the success of efforts to scaffold teachers' and students' experiences of inquiry within SSPs.

The Current Study

The current study is a case analysis of GLOBE ONE, a focused, time-limited field campaign that took place in northeastern Iowa from 2003 to 2005 and involved scientists, local professional development providers, educators, and students. Conceived initially as a project that would facilitate primarily scientists' own investigations, as the project evolved, the science aims were refined and education goals grew in prominence. The GLOBE ONE scientists came to focus on a research question that was of potential relevance to local agricultural practice and that many of them could use their protocols and instruments to measure: the effect of till versus no-till agriculture on Earth systems in northeastern Iowa. To promote more school and student involvement in the project, education goals were refined and additional professional development added over the course of the campaign that focused on student inquiry.

In this chapter, we present our case analysis, which relied on observations, interviews, and focus groups with GLOBE ONE participants and sought to address the following overall research questions:

- To what extent did GLOBE ONE achieve a balance of education and science goals, such that both educators and scientists could succeed in achieving their aims through the project?
- How well did GLOBE ONE's supports for student inquiry facilitate teachers' and students' engaging in their own investigations using GLOBE ONE data?

Methodology

We adopted an explanatory case study approach (Yin, 2003) to studying GLOBE ONE to address our research questions in such a way as to generate data that could help us not only evaluate the success of the project but also to explain why it did or did not achieve a balance of science and education goals and support student inquiry. In this approach, researchers typically begin with a set of rival hypotheses related to the phenomenon. Next, instruments to gather data with respect to the hypotheses are developed; care is taken to develop questions for rival or alternative explanations, to help reduce the common problem of confirmatory bias in case study research (Yin, 1992). In case studies, it is easy for researchers to "find what they are looking for" and neglect evidence that contradicts their initial theories, unless they look explicitly for plausible counter-explanations of phenomena.

We began similarly with a set of rival hypotheses in our case studies of GLOBE ONE, and our hypotheses focused on explaining both the potential success and failure of the project with respect to meeting the education and science goals. Given that the outcome was unknown but that factors from the literature might help predict success or failure, we used that literature and knowledge gained from evaluating the GLOBE Program to generate the our hypotheses. If the project reached both its primary education and science goals, we hypothesized that the chief reasons for success would be the effect of scientists' presence in motivating and preparing students to collect accurate data and that scientists would have successfully adjusted their process of inquiry to map onto school realities in order to achieve the goal of 10 publications set by the program for scientists. If the project failed in helping meet both science and education goals, we hypothesized that the chief reasons would be low interest and participation of schools and the compressed timeline for completing the science activities within the time allotted to the project. Appendix F includes a list of our rival sets of hypotheses.

With respect to students' opportunities to develop inquiry skills, we did not initially set out to study science inquiry but instead focused on students' emerging understanding of the nature of science (Lederman, 1992). As the project evolved, however, it became clear that inquiry would be the focus of educators' efforts, so we began to focus more on the success of the project in fostering student inquiry. In that respect, our interpretations of the project's success are more subject to confirmatory bias, since we did not have a similar set of plausible rival hypotheses that guided our work. Nonetheless, our data do provide us with substantial evidence that teachers and scientists had begun to support student inquiry with GLOBE ONE data by the end of the project. We integrate that evidence into our case analysis about the success of the project in meeting education goals.

Sample

Our sample included GLOBE scientists, GLOBE partner staff (professional development providers in the region), teachers, and students who were associated with the project and who served as informants to us about the project's progress. The scientists involved in GLOBE included Principal Investigators (PIs) on grants funded by the National Science Foundation to support GLOBE science activities and conduct educational outreach to schools. The PIs involved are listed in Table 5-1.

Table 5-1. Scientists Interviewed for Case Study Research

Scientist	Role in GLOBE	Research Area	Scientific Expertise	Role in GLOBE ONE
Dr. Russell Congalton, University of New Hampshire	Land Cover PI	Remote Sensing, GIS	Forestry	Coordinated project with Elissa Levine; interest is in land cover in region.
Dr. Elissa Levine, NASA Goddard Space Flight Center	Soils PI	Modeling Soil Systems	Agronomy	Coordinated project with Russ Congalton; focused on Earth science data integration and soils analysis.
Dr. Jim Washburne, University of Arizona	Soil Moisture and Temperature PI	Education and Water Resources	Evapo-transpiration and hydro-climatology	Installed and oversaw automated weather stations and prepared data for use by teachers.
Dr. Lin Chambers, NASA, Langley Research Center	Contrails	Aerospace Science	Aerospace engineering	Conducted clouds and contrails training; supported student inquiry project; reviewed contrail measurements taken by students.
Dr. David Brooks, Drexel University	Aerosols	Aerosols	Instrumentation for measuring aerosols	Installed and trained students and community college faculty to take aerosol and sun photometer measurements; supported student inquiry projects; reviewed data measurements from students.
Dr. Kevin Czajkowski, University of Toledo	Surface Temperature	Detection of Climate Change from Satellites	Atmospheric science, specifically, land and atmosphere interactions	Trained students on surface temperature measurements and donated infrared surface temperature thermometers.

In addition to scientists, teachers and students in five different schools served as informants in our research. As Table 5-2 shows, the teachers interviewed included both elementary and middle grades teachers, all with considerable experience in teaching. Only two were relatively new to GLOBE; others had been trained at least 5 years before the start of the GLOBE ONE project.

Table 5-2. Backgrounds of Teacher Informants

School	Teacher	Grade	Years Teaching	Years GLOBE trained
Central Middle School	Kelen Panec	7th	20	7
Hoover Middle School	Ana Houseal	8th	20	5
Immaculate Conception	Marita Schroeder	3rd	19	1
Kittrell Elementary/ Orange Elementary	Carol Boyce	5th	32	8
St. Edward Elementary	Carmen Devoe	4th	27	3

Finally, students assisted us with the research by providing us with insight about their experiences in GLOBE ONE. Table 5-3 shows the students grouped by school. Two groups of elementary students, and two groups of middle grades students served as informants. The majority of participants from whom we got perspectives were girls.

Table 5-3. Student Focus Group Participants

School	Grade	Students	Girls	Boys
St. Edward Elementary	4th	4	4	0
Orange Elementary	5th	10	8	2
Hoover Middle School	8th	6	6	0
Central Middle School	7th	5	1	4

Sources of Data

We relied on six primary sources of data for the case studies: interviews with scientists; interviews with teachers; interviews with other key actors, including the local GLOBE partner and the Chief Scientist at GLOBE; student focus groups; observations at trainings and in classrooms; and minutes of weekly teleconferences held with members of the GLOBE ONE planning team.

Scientist Interview Protocol. Researchers conducting interviews with both scientists and educators followed formal protocols, each designed specifically to match their role in GLOBE ONE (see Appendix G). Specific initial questions for scientists included queries about how GLOBE ONE fit in with their own research goals, how they chose their GLOBE ONE research question, why that question was important to their research, and whether schools would be able to collect all the needed data. As part of a postproject interview protocol, we questioned scientists about their view of the most significant moment in GLOBE ONE's evolution, the quality and usefulness of the data collected, and the expectations for where research would go (including publication in a peer-reviewed journal). In addition, scientists were asked about their contact with schools, and in particular about student responses to working with scientists, as well as questions about what activities students were doing as a result of GLOBE ONE and whether scientists viewed it as likely to continue.

Teacher Interview Protocol. Categories for teacher interviews (see Appendix H) included background and history of involvement with GLOBE and GLOBE ONE, views on participation in GLOBE ONE and how it fits with standards in Iowa, expectations and experience working with scientists and community members, and perspectives on the likely accomplishments and obstacles to success of the GLOBE ONE project.

Interviews with Other Key Actors. We interviewed three community members in the early stages of the study (see Appendix I). One community member had been hired by the Iowa Academy of Science specifically to work on GLOBE ONE, another was a volunteer at a local water quality monitoring program, and a third was a district contact with curriculum coordinators at GLOBE ONE schools. We also interviewed two GLOBE ONE operations personnel, local partner coordinator Marcy Seavey from the Iowa Academy of Science, and John McLaughlin of the GLOBE Program Office, and GLOBE Chief Scientist Peggy LeMone. For each of these informants, we adapted the teacher or scientist protocol and focused on questions of relevance to the interviewee's role in the project.

Observations. A researcher took part in the 2-day Inquiry Workshop for teachers, observing all aspects of the workshop. She took ethnographic field notes at the workshop, focusing on describing the material presented and on evidence of teachers' developing understanding of student inquiry.

Student Focus Groups. Topics covered in student focus groups included student understanding of GLOBE ONE data collection, student data reporting and analysis, and students' attitudes toward GLOBE ONE (see Appendix J). We also asked students to discuss their beliefs about the scientists they had worked with and why GLOBE ONE was important to scientists.

Minutes of Teleconferences. An SRI researcher participated in most of the weekly teleconferences in which progress and plans for GLOBE ONE were discussed among a subgroup of scientists and GLOBE staff involved in coordinating activity for the project. In reconstructing the overall narrative of the project, we relied primarily on minutes of the teleconferences to identify key milestones in the project.

Procedure

The main GLOBE ONE data collection in schools lasted from the winter of the 2003-04 school year through the end of the 2004-05 school year. For the GLOBE ONE case study, we conducted two interviews with each scientist and teacher, one in the early stages of the project and one toward the end of data collection, in spring 2005. We conducted interviews by telephone with scientists and in person with teachers. We tape recorded all interviews and constructed a verbatim transcript from all interviews. Observations took place in March 2005 as part of the 2-day workshop held at the Iowa Academy of Science on the campus of Northern Iowa University. The student focus groups took place on-site at schools in spring 2005. The meeting minutes reviewed began in fall 2003 and concluded with the October 28, 2005, teleconference.

An important limitation of our procedure is that the scientific component of the data collection ended in summer 2005, and analysis was slated to take place during the 2005-06 school year. Thus, the GLOBE ONE case study data collection focused mainly on the GLOBE ONE partnership in its planning, data collection, and early analysis stages.

Methods of Analysis

Analysis for the GLOBE ONE case study consisted of coding the qualitative data and exploring the trends that emerged. For the coding process, we compiled interview and focus group notes and created a coding matrix with codes for major categories relating to our rival hypotheses. The categories covered background, motivation for participation, contact among GLOBE ONE participants, how schools were supported, students' and scientists' research, and challenges and successes of GLOBE ONE. We coded scientists and schools separately for each code (e.g., "Support for Schools_School" and "Support for Schools_Scientist"), ultimately creating two coded documents, one that shed light on the scientist perspective and one that spoke to the school perspective. Two researchers coded all interviews. To ensure reliability, the researchers coded sections from five interviews, then discussed the definitions of the codes and refined the coding guide. After clarifying understanding of the codes, the researchers coded random sections from eight interviews and checked their levels of agreement. Coding of the complete interviews began once researchers had achieved 80% agreement on all codes.

In addition to the interview analysis, an overview of GLOBE ONE's goals and project development was culled from the meeting minutes and the GLOBE ONE proposal. We provide the resulting overview of the project goals and development in the next section.

The Evolution of Plans for GLOBE ONE: A Narrative Overview

GLOBE ONE was conceived in January 2003 at a GLOBE Principal Investigator meeting. The idea of a field campaign was a familiar notion to the GLOBE PIs, who had previously participated in NASA and NSF campaigns. The basic idea behind this type of scientific project is to engage an intensive data collection on a scientifically interesting question over a short period of time. Field campaigns have involved research on weather, soils, soil moisture, and vegetation. A specific science question local to an area is researched during a field campaign, and generally data are collected from different perspectives to allow for integrated views of the question.

Initially at least, the emphasis in the first and second meetings on GLOBE ONE in spring 2003 focused on science goals for the project. The initial January meeting was attended by science Principal Investigators in GLOBE, and the second meeting included the three NSF-funded education PIs (including the SRI International PI) and GLOBE staff but none of its regional partners. Also in attendance was the leadership of the University Consortium for Atmospheric Research (UCAR) and Colorado State University team that put together the winning proposal to manage the GLOBE Program for NASA through a cooperative agreement. Dr. Dixon Butler, then GLOBE Chief Scientist and director of the program, led these meetings and stated openly that the fundamental goal of GLOBE ONE was to be a *scientific* project, with the specific goal of supporting scientists in producing more peer-reviewed publications. Needed were more accurate and comprehensive datasets to support GLOBE's scientific mission, and there was an open acknowledgment among PIs present that the Program needed to improve with respect to its research productivity, especially toward the goal of promoting more Earth systems science through integrative analyses of data from multiple protocols. Butler committed $150,000 of GLOBE's operating funds to support the project.

At this spring meeting, those present discussed alternative sites for conducting such multidisciplinary research, and the conversation steered toward active partnerships in GLOBE. Partners in the GLOBE Program have been responsible primarily for teacher professional development and for linking scientists to schools; although some partner coordinators are scientists, their mission is primarily educational in nature. Further, these partners vary in the degree to which they are successful in promoting GLOBE data collection activities among schools they serve, and this variability can be linked to specific partnership practices, such as mentoring and follow-up support (Penuel & Means, 2004; Penuel et al., 2005). Two or three partner names were discussed before the team agreed to contact Marcy Seavey of the Iowa Academy of Science; her work had become well known among GLOBE staff as particularly intensive and successful in reaching schools that went on to implement GLOBE.

Seavey not only agreed to participate, she also agreed to host a summer meeting in 2003 of the science PIs and selected staff from the GLOBE Program's new offices in Boulder, Colorado. The purpose of the meeting was to identify the science question that would be addressed through the project; on the basis of this question, some number of the science PIs would collaborate to produce a white paper outlining the science question, methods, and potential educational outcomes of the project. Early in the day, as the group began to discuss potential research questions, two main challenges became apparent to the scientists present. First, none had particular knowledge or expertise of questions that could be investigated by studying Earth systems processes that were particular to northeastern Iowa. Only one scientist—Dr. Elissa

Levine—had expertise in soils, an area of obvious importance to Iowa agriculture. As a consequence, the conversation focused mainly on questions scientists' past research had prepared them to ask; accordingly, Seavey arranged for GLOBE scientists to talk with local scientists and take a tour of the area to learn more. A second challenge arose as scientists began to consider who would collect the data. If GLOBE ONE was to succeed in producing accurate data, there would need to be enough GLOBE schools in a particular area capable of collecting data on a regular basis. At one point in the meeting, the group migrated to a map of the state, where they could look at the location of GLOBE schools, and began thinking about potential questions and topics with these locations in the foreground. As Dr. Mike White, the initial scientific leader of GLOBE ONE, would later put it in a poster presentation at the Annual Meeting of the American Geological Union (White, 2003), the team had reversed a step in the scientific inquiry process, putting establishing the feasibility of data collection ahead of the definition of a scientific question (see Table 5-4).

Table 5-4. Mike White's Representation of the GLOBE ONE Process of Scientific Inquiry

The Usual Process	The GLOBE ONE Process
1. Have an idea	1. Decide we need more papers
2. Develop a hypothesis	2. Decide to have a field campaign
3. Find a good place to test the idea	3. Find high density of reporting U.S. GLOBE schools
4. Decide what methods/tools are required	4. Try to find relevant scientific questions
5. Write a proposal	5. Decide what methods/tools are possible
6. Conduct research, test hypothesis	6. Scrap for funds (no time for a reviewed proposal)
7. Write papers	7. Implement?
	8. Write papers?

Initially, scientific attention focused on the possibility of exploring how changes in land cover, especially from agriculture to restored prairie and from agriculture to urbanized area, affected other Earth systems in the atmosphere and hydrosphere. Planners expected that GLOBE protocols would need to be augmented with "additional instruments and observations" to answer the more specific research questions generated from this broad question. The method for the research would combine intensive (deep and from automated data collectors) and extensive (broad and by students) data collection on different land cover types. The datasets were expected to be of high quality and, unlike other GLOBE collections, to be complementary to allow for a systems view of the study sites. The ambitious goal for GLOBE ONE, at least initially, was to involve *every* school in Black Hawk County, as well as community members, by way of active local supervision and incentives.

Attending the meeting representing educators was a part-time staff member from UCAR (Sharon Sikora), the local partner coordinator (Marcy Seavey), and the PI for the evaluation team (Bill Penuel). In addition, Seavey had lined up some teachers whose schools the team visited and who spoke with the team over lunch. At least initially, educators voiced concern about aligning their participation with their district's goals for learning as outlined in the local standards. Although Iowa as a state had no state standards at the time GLOBE ONE was implemented, each county had its own standards, and progress toward standards was measured through annual testing using the Iowa Basic Test of Skills (ITBS). Educators were also concerned that whatever they were asked to do would be "research-based"; specifically, they wanted to know whether there was research support for the idea of teaching students science through an inquiry-based approach.

In a memorandum written immediately after this meeting to the team working on planning for GLOBE ONE, Sharon Sikora outlined strategies to promote educational goals in GLOBE that were to be the basis for an "education white paper…to help all to know the goals and objectives" of the educational component of GLOBE ONE. She wrote that it would be valuable to create a network for teachers to support one another in implementation, to show alignment of GLOBE with the ITBS, and to maintain regular contact with GLOBE teachers. She also emphasized the need for the GLOBE Program to support the project through recognition of participation and by explaining the goals of the project to local administrators. Finally, she suggested it would be important to offer professional development to teachers in how to facilitate student research in the classroom. A specific strategy offered included helping to make the scientists' questions "educator-friendly," to enable teachers to explain better to students what scientists were doing.

The first draft of the white paper produced by Mike White reflected the continued prominence of scientific goals but also suggested that significant resources be allocated to support education goals. The white paper stated that "the primary goal of GLOBE ONE is to gather numerous high-quality and complementary datasets with which GLOBE and non-GLOBE scientists will address significant research topics" (p. 1). Existing GLOBE schools were to "be informed of GLOBE ONE activities" but were not to be full partners in the project. At the same time, although the majority of the budget was proposed to support PI activities and the purchase of scientific equipment to allow for automated data collection that would not depend on students to collect data, roughly one-fifth was to support staff time for Marcy Seavey and a full-time coordinator for the project. Although one of the duties of the coordinator was to ensure high-quality data collection, much of this person's role was to be dedicated to working with schools and community members to maintain involvement in and commitment to the project and to conduct public relations activities to promote the benefits of the project. Seavey's work was to support professional development and training for teachers, as well as to follow up with those teachers, and to manage the full-time coordinator.

At the time that the UCAR-CSU collaborative took over management of GLOBE, the question of funding for GLOBE ONE remained very much in the air. New Chief Scientist Peggy LeMone at that time expressed reservations about the project overall, since the scientists did not appear to have settled on a research question. In the initial draft of the white paper, 18 separate questions were listed, each "owned" by a separate investigator rather than organized under a single multidisciplinary focus. Further, the goal of the project gave central prominence to high-quality datasets, rather than to the questions themselves. LeMone and others at GLOBE were concerned about the lack of a focused question and thought that the reversal of the typical process used for generating funding for a project through a process of peer review undermined scientists' motivation to participate:

> GLOBE ONE was the reverse from the usual process, it gave money up front. So the incentive was not quite there; these guys [GLOBE Science PIs] are scattered over the country and overcommitted like everyone else. It was harder for them to get together, plus they had the dollars so the incentive wasn't there to do better.

GLOBE ONE suffered a further setback when Mike White's tenure committee suggested that he drop his involvement in the project. Ironically, despite the project's emphasis on science, his committee felt the project would appear to be an educational outreach project that did not advance understanding of science in his field. They advised him that he needed to spend more time on other research, noting that GLOBE ONE would take up far too much of his time.

To be sure, the new leadership was far from opposed to the idea of GLOBE ONE. Peggy LeMone had been involved in several successful field campaigns in the past and believed them to be a particularly powerful model for collecting data that yield valuable scientific advances in Earth systems science (LeMone, 2003). Further, the GLOBE ONE concept fit well within the new leadership's idea of creating GLOBE Learning Communities, that is, groups of local educators, community members, and scientists that might engage in GLOBE-sponsored scientific and education activities of particular significance for a regional topic or issue. GLOBE ONE's planned involvement of community members and educators seemed an ideal place to UCAR-CSU staff for testing some of these ideas.

Peggy LeMone, rather than pushing to end the project, sought to provide it with new leadership and to encourage more senior PIs with tenure to step forward in leadership positions. Two PIs, Russ Congalton (Land Cover) and Elissa Levine (Soils) both stepped forward and helped LeMone to refine the research questions and revise the white paper. For the project, they consulted several local scientists in Iowa and brought the 18 subquestions initially identified under a single rubric and focus:

> For corn and soybeans, what are the environmental impacts associated with different frequencies and intensities of soil tillage farming, and with different amounts of crop residue left after planting as compared to prairie and urban sites?

The new draft, published in March 2004 on the GLOBE ONE Web site, included a literature review for each discipline involved in supporting data collection and specific plans for supporting accurate data collection with the support of automated data collection stations. In addition, the UCAR team set up weekly teleconferences with the planning team to advance work on the project and revitalize the commitment of scientists.

The new draft of the white paper gave more prominence to education goals than earlier drafts had done. The goals as stated were given a qualifier in the text, now referred to as the "scientific goals," and a separate section listing "Science/Education Partnership and Infrastructure Goals" was incorporated into the draft. Not surprisingly, the idea of creating a GLOBE Learning Community was given prominence in these goals. Some of the other ideas for education included a goal for "both students and scientists [to] analyze the collected data to help answer research questions" (p. 4). GLOBE ONE would promote student use of GLOBE ONE data and encourage students to ask science questions, and scientists and partners would aid students in their project.

With the completion of the Web site and approval of funds from the UCAR-CSU team, the work on the project began in earnest in late winter 2004 with a local reception for community groups that Marcy Seavey organized and that was attended by Peggy Lemone, two GLOBE science PIs, and several students. At the same time, more specific plans for meeting education goals did not crystallize until summer 2004. In some respects, progress had been hampered by the fact that education goals had only recently been fully integrated into project plans, but there were other challenges as well to making progress. For several months, Sharon Sikora was able to dedicate only a small portion of her time to the project; the GLOBE Program's decision to add more time to her contract in winter 2004 provided new energy and resources toward advancing education goals. Further, initially the education team recommended and considered multiple possible strategies. A decision in the summer to plan a workshop to promote student inquiry helped give focus to the team's efforts. Much of the energy then went into planning this workshop; an unstated goal was to be able to use such a workshop to test new ideas for how to support student investigations with GLOBE data more broadly. GLOBE ONE provided an ideal context for testing such ideas, since there would be rich student-collected datasets from the field campaign, if all went well.

Evaluating the Success of GLOBE ONE in Meeting Science and Education Goals: Implementing the Plans

Evidence accumulated by summer 2005 suggested that the project had achieved some important successes in meeting its education goals but that not all of these goals had yet been achieved. On the one hand, the project had succeeded in meeting the specific education goal of fostering greater involvement among GLOBE schools in data reporting. Further evidence of success came from teachers' perspectives on a special inquiry workshop held to prepare them to initiate student projects with GLOBE data in their classrooms. However, the timing of the workshop in late spring meant that few teachers had opportunities to implement the ideas presented with students before the end of the school year.

With respect to the project's science goals, the project did yield data that scientists believed were of sufficient quality to be integrated into manuscripts for publication, but by summer 2005 no results had been published in peer-reviewed journals. There had been two conference presentations at scientific meetings (American Geophysical Union), but both presentations described the project as a whole; neither was led by a GLOBE science PI. At the same time, scientists reported that their collaboration efforts with schools had been rewarding, even though they required them to expend considerable time cultivating relationships with teachers and schools.

In this section, we consider the extent to which different factors we set out to explore in our research help explain this pattern of results and also help illuminate why education goals became more and more prominent over the course of the project. With respect to education goals, we consider the role of scientists in motivating and preparing students to collect data and the factors and events that helped teachers overcome commonly reported barriers to participation among schools. With respect to science goals, we consider the degree to which data quality and the compressed time frame figured into the pattern of results thus far.

Explaining Progress toward Scientific Goals

The team of scientists working on GLOBE ONE made fast progress toward setting up data collection instruments and processes after the approval of GLOBE ONE funds. Several other activities aimed at helping kick-start the project's scientific data collection activities also took place in spring 2004. Marcy Seavey hired a local coordinator to support data collection, and members of the planning team installed 10 GLOBE-ONE-provided Vantage Pro automated weather stations to collect temperature, soil moisture, soil temperature, and precipitation at 15-minute intervals—clearly more data than any school could hope to collect (and costing approximately 26% of the GLOBE ONE budget of $150,000). Additional teachers were also trained by Dr. David Brooks (Drexel University, Aerosols PI) on using sun photometer readings, and Brooks installed monitoring equipment on the roof of a school to measure solar radiation at the Earth's surface.

Measurements from these automated weather stations turned into a rich dataset for the scientists; however, the preliminary analysis showed subtle but not gross differences among the sites, and other explanations than tillage (such as crop density) could explain the differences. Scientists wanted to take more time to examine the data, including using an analytic model called the General Purpose Atmosphere Plant Soil Simulator, or GAPS (Robin, Levine, & Riha, 2001). The sheer volume of data, coupled with the small magnitude of differences across sites, slowed progress toward publishing results from these stations.

Still other scientists felt that the data collected for their subspecialty did not provide sufficient material for publication. Pyranometer data measuring solar radiation were interesting because it was unusual to have so many instruments in one location, but not novel enough to be publishable, according to David Brooks, the scientist overseeing the data collection. The land cover data to be collected by the schools were known ahead of time to need more than the expected 200 to 300 sites. Other atmospheric and hydrological scientists had already opted out of participating in GLOBE ONE, since they did not see how the data collection would advance their own research agendas appreciably. Instead, the volume of atmosphere and hydrological data was to serve as inputs to an Earth systems model.

In short, the data collection activities did result in a large volume of data collected from both scientists and schools, but not all the data were immediately usable for all participating scientists. Even if more time were available for scientists to analyze the data and prepare manuscripts for publication, it is unclear whether the goal of 10 publications could be achieved within GLOBE ONE. Below, we consider evidence for different explanations of why it is difficult to say whether the project will come close to succeeding in its scientific goals.

Data Quality in GLOBE ONE

In the past, using student-collected GLOBE data in scientists' research has been problematic because of problems with the consistency, location, and accuracy of student data collection (GLOBE ONE Planning Committee, 2004). To date, only a handful of schools each year make the GLOBE Honor Roll, which defines a level of consistency in data collection required for each investigation area. In addition, some protocols, such as land cover, require adequate sampling of different location types, and it is not easy for schools to meet the requirements for sampling. Third, there are often errors in student-reported data that are not easily detected until scientists review the datasets. Each of these factors explains scientists' skepticism about the value of student-collected data and scientists' intensive efforts within GLOBE ONE to monitor closely students' work as they collected data.

By spring 2005, it was clear that GLOBE ONE schools were collecting large amounts of data in comparison with what they had collected in the past. Students from two middle schools, Hoover and Central, heavily promoted and ran week-long (at Central) or 3-week-long (Hoover) MUC-a-thons. During MUC-a-thons, groups of teachers plus students or groups of students working solo took kits out to selected sites and gathered land cover data. At Hoover, students were offered extra credit for doing the protocol after school, which also pulled in their parents. A large map of the area that flagged the completed sites was placed prominently in the school, and students were free to choose their own study sites as long as they met the protocol requirements.

Despite this level of effort, there were problems with the land cover data students collected. Students who later tried to visualize their data by using the GLOBE Web server found errors that were traced to a GPS coordinate problem, which had to be manually fixed by a student worker at the Iowa Academy of Science over the summer. The land cover science team also found errors in about 20% of the data in a sample of 133 entries they checked, but these seemed to be only typographical errors. Other errors in the data were omission of dates on data sheets for surface temperature, which made the data unusable. Further, although the MUC-a-thons ended up collecting land cover data from approximately 250 sites and their goal was 300 to 350 sites, this fell short of the 600 to 1,000 the science team needed to validate the baseline map that the team was making of the area. Possibilities for obtaining the remainder of the data included student groups working in the fall of 2005 or the science team sending research assistants to Iowa, as they have done with other collections.

The decision to put significant resources into the purchase of automated weather stations helped scientists attain more consistent and reliable data and was based on a desire, among other things, to circumvent problems with student data. In this respect, the stations were quite successful, and the fact that they revealed subtle but not gross differences between till and no-till sites suggests that, unless their data were quite accurate, students' data collection efforts would not have yielded data in which such differences could be detected. At the same time, these stations did not prove to be an effective strategy for involving students or the community in data collection. By using automated weather stations, scientists were in some sense avoiding the challenge of building schools' capacity for consistent and accurate data collection.

The Compressed Time Frame

Several scientists agreed with Chief Scientist Peggy LeMone's assessment that the scientific inquiry process in GLOBE ONE in some sense was "reverse" from a typical process of inquiry. A typical process is for Earth systems scientists to decide on a research question, select a site based on the suitability of the site for addressing the question of interest, and then preparing a proposal for peer review. In GLOBE ONE, the first consideration was the need for scientific publications and the second to go to a site in which GLOBE schools were active. As a consequence, by the end of the planning process, some scientists opted not to participate because the site was not suitable for answering questions in their research agendas. Further, four of the six most active scientists in the project focused on issues related to instrumentation or their own protocols, rather than taking a multidisciplinary approach to the larger research question.

Had scientists had more time and proceeded as is more typical in the field, one might argue, many of the issues related to scientists' questions, the site, and interdisciplinary integration might have been resolved through that planning process. As David Brooks wrote in a conference presentation paper related to the project:

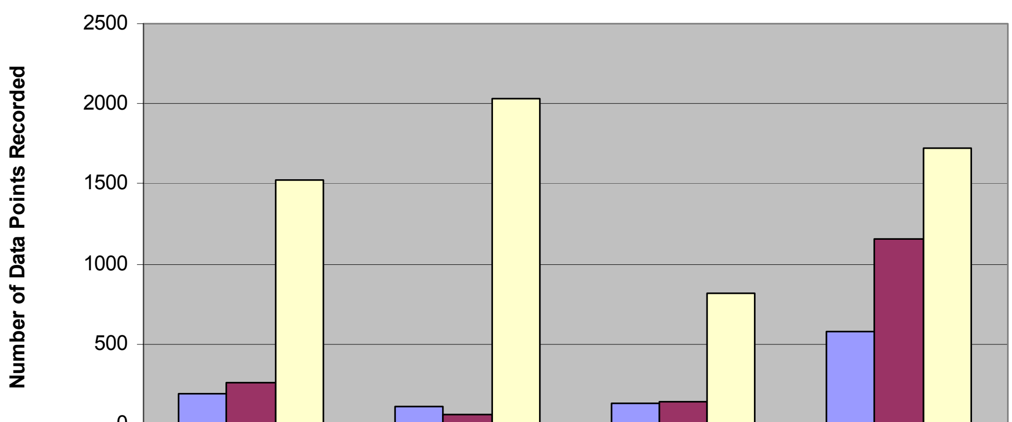
> As is often the case with science data, the presentation of selected results here masks the amount of effort required to obtain a result that can be summarized in a graph or two. First of all, collaborators must establish a working relationship. Goals and procedures must be specified clearly. It takes longer to do this when the backgrounds, experiences, and goals of collaborators vary greatly. Inevitably, points that seem perfectly clear to one collaborator are not at all obvious to another collaborator. Developing a comfortable relationship is especially important and time-consuming when collaborations are conducted at a distance, with most communications conducted through the impersonal medium of e-mail.

In an important sense, the timelines for the project were probably unrealistic from the start. The project was conceived and planned during the first half of 2003, and during this time the GLOBE Program underwent a major change in management. At the time the project was conceived, this change was imminent and known to all the scientists and to GLOBE Program staff. The original Chief Scientist who championed the project and had promised it funding left the Program shortly before the team at UCAR-CSU team took over. This new team was initially overwhelmed with the multiple tasks involved in taking over the management of such a large program, which has a reach of more than 100 countries. The questions the new Chief Scientist and others on the new management team had about GLOBE ONE were legitimate concerns, but scientists' negotiation with the new team took time and may have led to further delays. Finally, even if the project had begun in earnest with data collection in fall 2003, the scientists had just 2 school years to collect and analyze data, prepare manuscripts, and have those manuscripts go through the peer review process. The goal may have been a good one for the scientists, given their position vis-à-vis their funder, but in fact it would be impossible to achieve in 2 years.

Explaining Progress toward Educational Goals

The clearest evidence of the educational success of GLOBE ONE comes from an examination of data reporting patterns among the schools we studied. In three of four schools where teachers were interviewed and had been involved in GLOBE prior to GLOBE ONE, data reporting levels were significantly higher than their levels of data reporting prior to participating in the project (Figure 5.2). Although we can make no causal assertions about whether GLOBE ONE caused these increases, the comparison provides striking evidence that participation in GLOBE ONE correlated with higher levels of data reporting, suggesting that the project was successful at supporting teachers and students in collecting and reporting more data.

Figure 5.2. Data Reporting in Selected GLOBE ONE Schools



	Central Middle School	Hoover Middle School	Orange Elementary	St. Edward Elementary
2002-03	187	114	127	574
2003-04	260	61	141	1158
2004-05	1524	2032	817	1722

Further, there was some evidence that despite the late start of teacher professional development activities, a number of student inquiry projects had gotten under way and were in preliminary stages of development.

The Role of Scientists in Motivating Participation and Commitment

A key contribution of the scientists to supporting participation of schools was the training in protocols that several scientists provided beginning in the second half of the 2003-04 school year. In early 2004, GLOBE training was offered to a group of teachers in the hummingbird protocol (Bill Hilton, Hilton Pond Center in South Carolina), phenology (Elena Sparrow, University of Alaska, Fairbanks), and data analysis (John McLaughlin, Marcy Seavey, and Sharon Sikora). Bill Hilton later returned to teach the hummingbird protocol at a middle school and an assisted living center. On February 29, 2004, several PIs conducted a site visit to Black Hawk County to survey eight agricultural and two prairie sites, which constituted the first major data collection activity for GLOBE ONE.

Subsequent visits by science PIs each month in the fall and winter of 2004 further helped establish schools' capacity for data collection to support the scientific goals of the project. In fall, Russ Congalton gave a public talk and then trained a small group of students and teachers in how to classify land cover by engaging them in a hands-on MUC-a-thon. MUC-a-thons had been used successfully in the past by Congalton and his team to support time-limited but intensive capture of land cover data through manual classification by students (Congalton, Rowe, & Becker, 2001). Subsequent trainings focused on soil moisture, hydrology, soils, and surface temperature protocols for schools.

In addition to being available to support teachers in person, several scientists maintained regular e-mail contact with teachers related to their students' data collection. This communication had the effect that when teachers asked for help, scientists helped extend the scope of resources that teachers involved could use in teaching science. As one scientist put it, it is valuable "to help make those connections both in a science sense and a people sense." Teachers were grateful for this kind of assistance; as one put it, the scientists are "just inspiring to be around."

All the teachers said that scientist visits were especially motivating to students as well; in particular, one fifth-grade teacher said the project had served to turn around a student having difficulty in school.

> We had a student who's been challenged in school, a discipline problem, and his teacher asked if he could come [on the day of a scientist visit] and I said sure, because I always like to take on those kinds of challenges. He made a complete turnaround after he met the scientist. He seemed to really buy in to school and…there's a reason for why we're doing this stuff called school. And he's changed his behavior, too, but it's the enthusiasm and excitement, and I think the kids are just really proud when they get to tell people that they had a scientist in their class.

Another teacher (who joined in the spring) talked about exciting changes in a task she has had her students do every year:

> I do an activity with my kids…where I have them draw what they think a scientist is; [then] I have them…draw another picture at the end of the year, and this year it was really surprising to see the number of students who drew themselves.

These two examples are representative of successes talked about by all five teachers. The personal nature of the GLOBE ONE project, the scientist visits, and the media attention it brought all were highly motivating to students and teachers. Schools submitted markedly more data than they had done in years previously, and students were proud of their contributions to the scientists' research.

Importantly, from focus groups we learned that what motivated students principally was the general sense that they were contributing to science; students did not develop a clear understanding of the science question scientists were seeking to answer. When asked whether they understood what scientists were trying to find out in GLOBE ONE, most students participating in focus groups could identify broad goals, such as comparing the weather in different places or validation of satellite data. Students had little or no idea about tillage or about the main scientific research question being explored, but they were confident that their data were being used to see on the ground what scientists couldn't see from satellites or from other places. One fourth-grader collecting atmosphere data said "It helps the scientists, gives them information about here. They don't live here, so they don't know what the weather is like here." Another student in the seventh grade who was collecting sun photometer data said that the students were doing "checks and balances with the satellites."

For their part, teachers admitted that they sometimes forgot to share information with their students about progress on the project they learned from GLOBE ONE scientists, but they were still confident that students were learning important lessons about how science works. Teachers did not emphasize the larger scientific question of how tillage was affecting the local environment, but they thought students all felt their data collection was for an important purpose and students' involvement in the project improved their science learning significantly. One teacher noted that with GLOBE ONE students "notice more" about the scientific phenomena they study, such as clouds and temperatures. Another teacher reported that science learning became "more personal" with GLOBE ONE, and students asked more questions about what they saw in their local environment.

Other Supports for Participation

GLOBE's scientists would be quick to admit that their efforts to promote schools' involvement would have been ineffective without local support for overcoming barriers to implementation. Our case study researchers found that many of the barriers faced by teachers implementing GLOBE were clearly evident from the start of GLOBE ONE in northeastern Iowa. Teachers reported that it would be difficult to find time to integrate GLOBE activities into their curriculum and standards, and they cited difficulties with the Web site and the need for administrative support as challenges, all factors previous evaluations of the GLOBE Program indicated can cause teachers not to implement the program activities. Yet, despite these challenges, teachers did implement the project and at much higher levels and with greater breadth than they had before.

One reason why teachers chose to implement the project was the support for participation organized by the local GLOBE partner coordinator, Marcy Seavey of the Iowa Academy of Science. Marcy Seavey provided support for materials, such as instrument shelters, as well as mentoring support to teachers. She also enlisted the support of community organizations, such as the Audubon Society, a local milling company, and the Boy Scouts, each of which provided support for the project by donating materials and raising money for teachers. The scientists who visited teachers' classrooms provided material support (e.g., instruments such as thermometers and pyranometers) and motivated teachers to stay committed to the project.

Of these supports, teachers perceived the GLOBE partner's support as especially valuable for the day-to-day implementation. When asked who or what kept the project going for them, all five teachers immediately answered that they would not have been able to implement the protocols as well or as often without Marcy Seavey. As one fourth-grade teacher put it, Seavey has been "instrumental in keeping this organized; she does an awesome job, and she's so enthusiastic, good-hearted, and ever-helpful and willing to take the time to help." Another eighth-grade teacher said that "Marcy's been very supportive in what we're doing. We e-mail and talk extensively, quite often." Students also knew Marcy Seavey, and students in focus groups in two schools mentioned that she had come and helped their class. Finally, a fifth-grade teacher said she felt that "implementing the program without the support of these people and organizations would have been absolutely impossible."

Teachers also noted that their principals and school leadership in general were more aware and supportive of GLOBE ONE than they had ever been with GLOBE. This difference was due mainly to the press attention the project got when scientists visited, as well as a letter students wrote to their paper when their instrument shelter was vandalized. A number of articles were published in local newspapers, with headlines such as "Keeping Learning Cool: Project with GLOBE team lets St. Edward's students learn about weather while providing data for scientists to study" and "Temperatures rising: Black Hawk county farmers participate in worldwide weather study." These articles, as well as the event of having reporters visit schools and interview teachers, served to demonstrate to administrators the importance of the GLOBE ONE project. Most teachers were quite impressed with the amount of press coverage the project got, though one teacher wished there could have been more.

The Role of the Inquiry Workshop in Fostering Student Investigations

More than any other component of support provided in the GLOBE ONE project, organizers, scientists, partners, and the teachers who participated all agreed that the March Inquiry Workshop was one of the most significant moments for GLOBE ONE, as well as for the GLOBE Program more broadly. Teachers were excited about doing inquiry projects with their students using local data and, had the workshop occurred earlier, would probably have carried even more of what they learned back to their students. Because the Inquiry Workshop had such a significant impact despite its timing, we describe it here in more detail, as well as some of the student projects that emerged from it.

The 23 teachers who participated in the Inquiry Workshop and completed surveys had an average of 16 years of teaching experience, ranging from preservice teachers about to embark on their first year of teaching to veteran teachers with 38 years of experience. Seventy-four percent had never been GLOBE trained; the other 26% (six teachers) had had previous GLOBE training. Three teachers were involved in the GLOBE ONE field campaign, and two became involved after the workshop. Thus, although not all GLOBE ONE teachers participated, the workshop did motivate a few new teachers to get involved, and one teacher also noted that the excitement generated by the GLOBE ONE Inquiry Workshop made another teacher in her school consider doing GLOBE the following year. As this teacher said:

> I think the best thing that came out of [the Inquiry Workshop] was that [a teacher] came back to school and implemented something with her kids and was very successful at it, and was really pleased…And then my colleague, who teaches the other eighth-grade team, said after [this teacher] came back and had such a good experience, she said, "Oh, my gosh, I think I'm going to go ahead and get GLOBE trained next year." So I would say that would be the benefit.

Teachers reported that the workshop provided a unique hands-on opportunity for them to apply what they were learning about inquiry. When asked on completion of the workshop how confident they felt about their ability to implement inquiry in their classrooms, 87% of participating teachers responded that they felt confident or very confident.

During the Inquiry Workshop, teachers became excited about and interested in the GLOBE ONE data used for projects in the class. The main task in the workshop was for teachers to go through the process of designing an inquiry project using GLOBE ONE data, and most participants designed interesting projects that included research questions, a hypothesis, independent and dependent variables, a procedure (including how to do the project by using the GLOBE Web site resources), and analysis and conclusions. For example, an elementary and a middle school teacher working together asked the question: "Is there seasonal variation in air temperature in the months of June, October and December when comparing John Deere Prairie and Sand Prairie?" They then generated graphs using the minimum and maximum temperature data from two automated weather stations, showing that the difference in air temperature between the two sites was never more than 3 degrees. Their conclusion was that the different surfaces of the two prairies did not appear to be affecting the surface temperature. Having completed the process of an inquiry project themselves, these teachers were more confident that they would be able to do inquiry projects with students in their classrooms. As one middle school teacher completing this project wrote:

> It was a great workshop and it was very helpful. I appreciated the ideas and lessons I can now use.

On the whole, teachers were very satisfied with the workshop and felt that it provided them with useful tools for implementing inquiry projects with their students; more importantly, it motivated them to take the time for inquiry in their classrooms. Criticisms of the workshop came mainly from one preservice teacher, who felt that it was a lot of information to take in without having had experience in the classroom, and a few others who felt that they would have been able to implement more if the workshop had happened earlier in the year. In fact, the timing of the workshop meant that many projects conceived or planned at the workshop would have to wait until the fall, after our own case study data collection was complete.

Even though data from the automated weather stations was intended to support scientists' aims, these data played an unintended and helpful role within the Inquiry Workshop. Using automated weather station data, as well as student data that had been collected nearby as part of the Inquiry Workshop, motivated teachers to think carefully about their research projects and how they could bring locally relevant inquiry tasks to their students. One fourth-grade teacher we interviewed described an inquiry project she did with her students that was inspired by the workshop:

> What was really interesting in…about the third week of April, our local newspaper ran an article about GLOBE work that the farmers were doing. So they talked about how the GLOBE team had some instruments set up in fields that were collecting temperatures and sending it in to GLOBE. The article was about global warming and about different farming practices. Well, that ended up becoming our inquiry work because we got a million questions…So then what we did for a week after that is we just studied the impact of…little miniature sites [around our school] and we took the surface temperature in class. And then they [the students] could see right away, well, this area's warmer, this area's cooler, so they started to get an understanding and could relate it to the article about the farm.

Without the experience of the Inquiry Workshop and the data provided by the automated weather stations, this teacher said she would not have taken the time in her curriculum to explore the student questions about the farming article so deeply.

Discussion and Conclusions

In this final section of the chapter, we return to our original question about the degree to which, on the whole, science and education goals of GLOBE ONE were met and to the broader issue of balance of science and education goals in SSPs. We could reframe our original question thus: Why, in this project that focused initially on science goals to the exclusion of education goals, did education goals emerge as important, and why were they more easily met than were science goals?

The emergence of education goals can in some respects be traced to specific events and insights that the scientists had over the course of planning for GLOBE ONE. The selection of Marcy Seavey's partnership as the focus for the project meant that the project would unfold in an area where schools were already active in GLOBE and would be most excited about participating in the project. In the summer meeting in which scientists met with teachers in the area, it became clear that teachers would not participate simply to support scientists' efforts. Taking class time for GLOBE would require them to demonstrate to their site and district administrators that the scientific activities and student inquiry could contribute to official goals for student learning (local standards) and be aligned with assessments in science. Further, the allocation of time and resources by the new GLOBE management, especially in the efforts of Sharon Sikora, meant that time would be given to developing an education plan on par with the science plan. Early on, Seavey's time had been directed toward immediate support to both scientists and schools and to networking the GLOBE scientists with community groups and with local farmers and scientists. She would not have had the time to plan the successful Inquiry Workshop on her own, without support from the GLOBE Program Office.

In another sense, though, one could view the emergence of the education goals as a necessary step toward ensuring the success of the scientific endeavors of GLOBE ONE. Responding to teachers' needs to show how participation would align with local standards would result in higher levels of data collection and reporting, if properly supported. Although the evidence suggests that student-collected data remain of limited value to the scientists, scientists did believe initially that such data would need to be incorporated into their analysis activities, and the original vision of Dixon Butler included a focus on *student-collected* data. Thus, allocating more time and resources in the project budget to support teachers' and students' participation could be viewed in retrospect as a wise decision and a necessary step toward achieving the scientific goals of GLOBE ONE.

The additional attention given to education goals over time in the project made GLOBE look more like a student-scientist partnership than it was initially designed to be. Over the course of the planning period, educators' goals and perspectives gained more and more prominence, and planners emphasized the potential benefits of direct contact between scientists and schools. Further, *student* inquiry emerged as a focus point within the education plan for GLOBE ONE, which meant that students' questions and analyses of data would be more strongly emphasized. Scientists, for their part, agreed to support students' projects, by answering student questions and providing guidance to students when they were on-site at schools, over e-mail and via video-teleconferencing.

The education goals also proved to be easier to meet within the project than were the scientists' goals. The scientists' presence, the support from the partner coordinator, and the excitement of teachers who attended the Inquiry Workshop led to a dramatic increase in implementation of the project and generation of plans for student projects. By contrast, although some scientists were able to collect data from automated stations that were of sufficient quality for publication, whether student data can be used is still unknown, and it is unclear whether resulting papers will be able to address the overarching question originally posed by the team. Certainly, the compressed timeline meant that the goal of achieving 10 papers in peer-reviewed journals by fall 2005 could not be met. In addition, this compressed timeline forced the scientists to change the typical sequence of activities in planning a major multidisciplinary integrated field campaign.

In one important respect, the *imbalance* between the success of scientists and educators in meeting their goals in the project suggests one way that GLOBE ONE provides a negative exemplar of an SSP. Ideally, SSPs address needs of both scientists and educators (Means, 1998), but GLOBE ONE was more successful on the whole in meeting educators' needs than in meeting the needs and goals of scientists. As we argue below, both the model of support for teachers and the transformation of the scientific inquiry process itself may be necessary to achieve a balance of education and science goals in an SSP.

GLOBE ONE as a Negative Exemplar of an SSP

By being more successful in meeting educators' needs for an SSP, GLOBE ONE represents an example of what an SSP should *not* be. GLOBE ONE did not succeed fully in realizing scientists' goals because of the difficulty in coordinating different scientists' needs and goals into a multidisciplinary field campaign, problems with quality of student-collected data, and the compressed timeline. The issues associated with coordinating *multiple scientists* working on a single research problem as part of a field campaign are challenging enough and well known to the field. Crosstalk that results from scientists working across disciplines and conflicts over resources, instrumentation, and management all make campaigns difficult to pull off, even in the best of circumstances. Making students and schools part of the campaign puts additional stress on the collaboration effort and requires considerable time to coordinate. Within the compressed time frame of GLOBE ONE, this coordination activity took up most of the scientists' time. Future SSPs might learn from this experience by planning to allow for more time for coordination among scientists working across disciplines and between scientists and schools.

From many of the scientists' points of view, GLOBE ONE was also problematic in that the planning process failed to incentivize scientists to work together to construct a question and research plan that would be of wider significance and interest to the scientific community. Funding was not contingent on scientists' ability to write a convincing proposal that passed through a peer review process, but instead was promised as an incentive to help them to write more scientific papers. The absence of peer review led scientists to give less attention to situating their multidisciplinary work within the existing scientific literature, as reflected in the initial draft of the GLOBE ONE white paper. Further, the initial framing of the goals of the project—collecting high-quality data and publishing papers—put emphasis on the process and result but not on the goals or questions that could be addressed. In this respect, GLOBE ONE failed to give primacy in its planning to the formulation of a scientific question and to the development of hypotheses.

GLOBE ONE as a Positive Exemplar of an SSP

There is an alternative perspective to the scientists' point of view that the inquiry process was in some sense "reverse" in GLOBE ONE, and it suggests a way that the project was a positive model for SSPs. In some sense, part of the process must consider schools' needs and site requirements and limitations in light of those needs for a successful SSP to emerge. Site selection should flow from a research question, as the scientists argue, but it must also factor in the availability of schools to support data collection efforts. If it does not, then education goals are unlikely to be met. In this respect, the GLOBE ONE experience offers a positive model for the field. Scientists carefully considered how to involve and include schools and their students in the data collection process. They supplemented student-collected data with instruments that would not depend on the accuracy or consistency of student-collected data alone, and these data in turn proved to be useful for supporting both scientists' and educators' goals. Scientists could use these data because they provided sufficient consistency and were accurate enough to be sensitive to small differences among till and no-till sites, and students could use the data to answer their own research questions as part of classroom investigations.

The success of the project in meeting its education goals offers further lessons for the design of effective SSPs. Teachers could not have implemented GLOBE ONE data collection or inquiry activities without some specific kinds of support, each of which were provided through the project. First, the local partner coordinator helped teachers see the alignment of their activities with their district's goals and assessments, and helped to convince teachers' administrators of the value of participation. Second, scientists had extensive face-to-face contact with schools, supplemented by occasional e-mail contact in which they provided support to teachers and schools. Their contacts with schools motivated both students and teachers, and their training activities prepared teachers to implement data collection protocols and carry out data reporting activities necessary for the success of the project. Finally, the design of a workshop that focused specifically on student inquiry helped prepare teachers to make the experience of GLOBE ONE a deeper one for students, by engaging them in planning for student investigations using GLOBE data.

Implications for Future Research on Student-Scientist Partnerships

Our research on GLOBE ONE as a student-scientist partnership reveals two gaps in the existing literature on successful SSPs. First, there is a need to identify models of SSPs in which scientific research aims have been successfully advanced and allocate adequate time for planning and carrying out projects. The GLOBE and GLOBE ONE experiences together reveal how challenging it can be to publish scientific research using student-collected data. Examples of successful use of student- and amateur-collected data that result in scientific advances—and not just in validation studies of data quality—are not widely known within the educational research community. If such examples exist, more must be learned about the time frames associated with planning for the projects and with school involvement. The sustainability of SSPs as a model for bringing students closer to science depends on scientists' finding ways to achieve their own goals for research, since professional rewards (including tenure) follow from their involvement in scientific rather than educational activity.

A second area of research on effective SSPs that needs further attention is the role of reform intermediaries and other local partners in supporting teachers' and schools' participation.

Reform intermediaries are organizations that are partly outside the school system but that work within it—the Iowa Academy of Science is a good example—to effect change (Cohen, 2000; Honig, 2004; McDonald, McLaughlin, & Corcoran, 2000). In GLOBE ONE, Marcy Seavey and her assistant at the Iowa Academy of Science were critical to ensuring the success of the project in meeting its educational goals and in mediating contact with scientists. Her expertise in both science and education made her an effective bridge between these two groups, and the time allocated for her to work on the project led teachers to feel more secure about their participation and scientists to become more connected to resources and expertise in the local community. In other SSPs, reform intermediaries are likely to be able to play critical roles; therefore, a closer examination of the conditions under which they are most successful across a range of SSPs would be likely to help designers in locating good intermediaries in an area and in hiring effective liaisons between scientists and schools.

Overall, the GLOBE ONE story is a success story for education, but it is also a cautionary tale. It is a story in which real and frequent contact between scientists and schools led a motivated group of students and teachers to engage in an ambitious scientific field campaign, supported by local reform intermediaries. But at the same time, the difficulties faced by scientists in using student-collected data suggest that some of the hopes for SSPs must be tempered by an awareness that until successful examples of SSPs that truly meet scientists' needs for discovery can be found, SSPs remain at risk of becoming a method for bringing students closer to science that is seen largely as a one-sided investment that benefits only the students in the partnership.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

In this final chapter, we describe conclusions from results of our evaluation research studies. We focus on conclusions related to challenges associated with maintaining the scale of GLOBE, improving student achievement, preparing teachers for implementation, and establishing conditions necessary for effective science projects or field campaigns such as those planned for Next Generation GLOBE (NGG). In addition, we present recommendations associated with each conclusion, focusing on recommendations that address specific elements of the NGG plan.

Conclusions from SRI's Evaluation Research

Conclusion 1: The GLOBE Program is at a critical transition point with respect to its scale.

Total data reporting, one indicator of the GLOBE Program's reach and scale, has been level for the past several years, as has the rate of persistence in data reporting among GLOBE schools. On average, just one-fifth of all schools that have teachers trained in GLOBE go on to report GLOBE data to the Web site. Those that do report data tend to continue to do so for at least a year; roughly 4 in 10 continue for 2 years or more, suggesting that GLOBE does have a committed core of teachers within the program.

Although data reporting indicators are a broad measure of implementation, a better measure of implementation—Honor Roll data—show similar kinds of trends. With one exception—Advanced Atmosphere protocols—the number of schools that meet scientists' standards for data consistency has either decreased or stayed the same in the past 5 years.

However, in the past few years, there has been a steady decrease in the number of new teachers trained in the program. To maintain current levels of data reporting, more new teachers will need to be prepared to implement GLOBE, or teacher professional development will need to become far more effective in promoting implementation. Alternatively, Next Generation GLOBE might decide to support its core of steadily reporting teachers to ensure continued implementation in schools. However, given the trends now being documented, action will be needed to ensure that the overall reach of the program does not decrease.

Next Generation GLOBE also could select different metrics for measuring implementation. A decision to choose new metrics to measure implementation and scale within GLOBE may yield more accurate data on implementation, since many teachers and schools collect data they do not report, and past evaluations have found that one barrier to implementing GLOBE is that teachers do not see the educational value of reporting data. However, data reporting has provided the Program with an invaluable pulse on schools' participation; comparable new metrics that teachers would be motivated to report to the Program may be difficult to construct. Data reporting has had the advantage that it is relevant to both the scientific and educational missions of GLOBE (Penuel & Means, 2004).

Conclusion 2: For GLOBE to increase student achievement in science, students must engage with the subject matter content behind protocols and in data analysis activities.

Our student achievement study, conducted on a large scale and using quasi-experimental methods, has validated an earlier set of findings about what aspects of GLOBE implementation matter for student learning (Penuel et al., 2002). Collecting data by using protocols and participating in learning activities did not predict how well students performed on our test of knowledge or on our test of students' inquiry skills. The only positive significant effects for any aspect of implementation we found in our study this year were effects for breadth of coverage of subject matter content that is included in background material in the Teacher's Guide and for conducting data analysis activities with GLOBE data.

These results are different from some of our past studies of the GLOBE Program's effects on student achievement in science, in which we compared scores of students from higher-reporting GLOBE schools with scores of students from lower-reporting GLOBE schools (Coleman & Penuel, 2000). In those studies, we did find positive effects of GLOBE on students' environmental awareness and problem-solving skills. It should be noted, however, that in those earlier studies we did not attempt to measure the effects of different implementation components since we relied on smaller samples of classrooms. Because we had sufficient variability in classroom implementations this year and in our Year 7 study, we can be more confident about these findings. Our primary caution in interpreting findings from this year's study relate to the reliability of our assessment measurements for students in the sample, which proved to be somewhat lower than in Year 7, even though the instruments used were the same. However, the congruence of these findings with the one other larger-scale achievement study we conducted suggests that the findings may not just be attributable to chance or measurement error.

We hypothesize that the findings about subject matter content coverage and data analysis can be interpreted in reference to past research findings and in relationship to how data analysis aligns with parts of our knowledge test. Past research has found that when teachers cover content aligned with assessments and do so by engaging students in cognitively complex tasks (e.g., constructing explanations of phenomena versus fill-in-the-blank worksheets), students' scores on standardized assessments tend to be higher (Porter, 2002; Porter, Floden, Freeman, Schmidt, & Schwille, 1988; Porter et al., 1993). Therefore, it is not surprising that, in the case of GLOBE, we can draw a similar conclusion from our findings on the student assessment. To explain why data analysis figures into performance on our knowledge test, it is important to note that some of the questions require students to interpret or read graphs relating to content covered in the Atmosphere protocols. These items, adapted from released items of the National Assessment of Educational Progress, are core skills students are expected to master in middle school science. Data analysis activities, more than any other type of activity in GLOBE, are likely to prepare students to interpret data from graphs and to detect patterns and trends, as these questions require students to do.

Conclusion 3: Initial protocol training that focuses on inquiry and includes time for teachers to plan for implementation results in higher levels of GLOBE implementation.

Findings from our study of what makes teacher professional development effective in GLOBE suggest that it is particularly important to focus on different aspects of inquiry and provide ample time for teachers to plan for implementation in their classrooms. A clearer focus on student inquiry appears to motivate teachers to report data, perhaps (as we saw in GLOBE ONE) because reported data can be used to support student investigations. Providing time for implementation, we found, makes it more likely that teachers will implement protocols with students and feel prepared to use GLOBE in conjunction with student investigations. Longer time provided for the training in general was also found to have a positive significant effect on protocol implementation.

These findings are largely consistent with other findings about effective professional development in mathematics and science education (Garet et al., 2001). Yet historically, allowing more time for inquiry and planning has been challenged by scientists in the GLOBE Program concerned with loss of time spent on protocols and by educators concerned that there are too few forums available to prepare teachers adequately for inquiry. Data from this study and from earlier studies we have conducted of partner activities, however, confirm the critical importance of conducting activities that help teachers "localize" GLOBE in terms of their classroom context.

Conclusion 4: Professional development is less likely to be effective if not followed up by equipment and support for setting up equipment.

Our past case study research identified helping teachers secure and set up equipment in their schools as one of the roles that mentors in GLOBE played in supporting implementation (Penuel et al., 2005). Our modeling techniques with a large sample of teachers confirmed that this assistance, which some partners have been able to provide, is critical to supporting program implementation. Teachers may leave workshops prepared to implement the Program, but without the specialized equipment for monitoring the environment that the protocols require, implementation challenges may be difficult or impossible to overcome. The fact that teachers seem to need help with both acquiring and setting up equipment suggests that GLOBE is not a "plug-and-play" program for most teachers and that a critical function of partners is to provide assistance to teachers on-site to support teachers' getting started with implementation.

Conclusion 5: The GLOBE Program can influence teachers' science instruction when they participate in protocol training as part of a group from their school and when the training is closely aligned with district policy and personal goals.

Many partners offer GLOBE training to teachers as a general form of professional development aimed at improving their science teaching (Penuel et al., 2004). It appears that although design elements of that training do not influence teachers' instruction, some aspects that relate to teacher recruitment do. When teachers participate with others from their school, they are more likely to report changes to instruction as a result of their training. Further, when they perceive that their professional development coheres well with their district's goals for students and their own goals for professional growth, they are more likely to report changes to their practice.

This finding underscores the importance of alignment (Knapp, 1997) in science education, which has been a theme of systemic reform initiatives for the past several years. It is particularly critical for curriculum supplements like GLOBE to be well aligned with local standards and, where they exist, science assessments. Typically, alignment is measured by curriculum experts who demonstrate mappings between particular materials and standards or assessments (see, e.g., Webb, 1999). Our findings also suggest that teachers' *perceptions* about alignment matter as well. No matter what mapping might exist between GLOBE and standards as construed by GLOBE partners or the Program Office, what matters for teacher change is whether teachers see the program as well aligned with what they want and are expected to do in their science classrooms.

Conclusion 6: Time-limited field campaigns with close contacts with scientists can be successful for teachers and students.

The GLOBE ONE field campaign proved successful for teachers and students in several key respects, despite the late start of education activities. First, the project was successful in motivating students and teachers through direct and regular contacts with GLOBE scientists.

Scientists not only helped with initial protocol training, they also visited classrooms and assisted teachers and students with projects via e-mail. Second, the project illustrates how an active partnership can work to facilitate or mediate school-scientist connections. The Iowa partnership helped bridge gaps in understandings and expectations between scientists and educators in ways that sustained the project over the course of the past year and a half. Third, the Inquiry Workshop designed for the project proved to be particularly successful in facilitating teachers' support for student investigations using GLOBE ONE data.

Conclusion 7: It is still unclear whether scientific research in GLOBE field campaigns can benefit from student-collected data.

GLOBE ONE did not succeed fully in realizing scientists' goals, in part because of the difficulty in coordinating different scientists' needs and goals into a multidisciplinary field campaign, problems with quality of student-collected data, and the compressed timeline. Within the compressed time frame of GLOBE ONE, coordination with schools took up a considerable amount of time. From many of the scientists' points of view, GLOBE ONE was also problematic in that the planning process failed to incentivize scientists to work together to construct a question and research plan that would be of wider significance and interest to the scientific community. Funding was not contingent on scientists' ability to write a convincing proposal that passed through a peer review process, but instead was promised as an incentive to help them to write more scientific papers. The absence of peer review led scientists to give less attention to situating their multidisciplinary work within the existing scientific literature, as reflected in the initial draft of the GLOBE ONE white paper. Further, the initial framing of the goals of the project—collecting high-quality data and publishing papers—put emphasis on the process and result but not on the goals or questions that could be addressed. In this respect, GLOBE ONE failed to give primacy in its planning to the formulation of a scientific question and to the development of hypotheses.

The findings from our case study of GLOBE ONE have potential implications for a key expectation of Next Generation GLOBE, namely, that scientists' support for student-collected data will not contribute to building scientific knowledge. Instead, a more realistic goal might be for scientists to work with schools to conduct educational outreach. In fact, many scientists may already have this expectation for student involvement, but there has remained—despite 10 years of difficulties—considerable hope for a different outcome in the GLOBE Program. A more realistic appraisal of what goals are appropriate for the student-scientist partnerships that will be fostered in the future is necessary, and the timing for such an appraisal is ideal, given the new emphasis on time-limited projects within the plan for Next Generation GLOBE.

Recommendations for Next Generation GLOBE

Recommendation 1: Identify funding sources for partners to enact strategies to increase implementation rates among trained teachers.

The NGG White Paper calls for the Program to "focus its efforts on quality, for instance developing high quality materials, activities and support services, rather than on quantity, for example recruiting large numbers of participating countries, schools, teachers or students." Implied in this statement is a recognition that past investments focused on improving the reach and scale of the Program yielded many teachers trained in the Program but little success with promoting its implementation. In fact, as we show in our Program Growth chapter, only about one-fifth of schools in which teachers were trained in the Program ever report GLOBE data to the Web site.

At the same time, the data on program growth suggests that there may be coming declines in the overall reach of the Program. Fewer teachers are being trained to replace those lost by attrition, such as when teachers' assignments change and GLOBE is no longer as well aligned with their new curriculum standards. The result in the coming years may be that the GLOBE Program faces a different challenge, namely, justifying a large infrastructural cost for a small number of core teachers. Despite what was perhaps too much attention to growing the Program at the expense of quality early in the Program's history, the challenge now may be to improve the likelihood that teachers who begin implementing the Program continue to do so over multiple years.

We have evidence from multiple studies about what partners can do to improve the likelihood that teachers they train will go on to implement GLOBE. What is not clear is whether most partners have the resources to provide the mentoring, equipment, and other follow-up necessary to achieve this goal. The GLOBE Program Office could work specifically toward helping partners secure funding for equipment purchases that could meet one of these challenges. With respect to funding more mentors and coaches for teachers, a good solution may be to recommend that partners team with other curriculum programs and professional development initiatives. Some states have been successful in linking GLOBE to other programs in this way, making available at least a part-time staff developer to support teachers who are implementing the program.

Recommendation 2: Focus on teachers in a systemic but not school context.

One recommendation within the NGG White Paper is for the GLOBE Program to work with schools rather than individual teachers: "educational research indicates that this is a more effective way to integrate an innovation into the curriculum" (p. 6). We believe that our research supports a slightly different point of view and that the recommendation to work with schools has a large risk associated with it, since when teachers leave a school they are likely to take with them their knowledge and experiences of implementation and not be able to apply them in their new assignments.

Our finding that perceptions of coherence and alignment are associated with higher levels of implementation suggests that, indeed, the school and district contexts are important factors in teachers' decisionmaking. Further, the fact that "collective participation" in professional development activities—that is, participating with others from one's school—predicted teachers' changes in practice supports the idea that school involvement is critical. However, we did not find a relationship between collective participation and protocol implementation or data reporting. In other words, we did not see the expected relationship between having more teachers from a single school receive training and higher levels of GLOBE implementation.

A further complication for the plan to involve schools is teacher turnover. Teachers are highly mobile professionals today; a telephone survey of a random sample of GLOBE teachers in the database would demonstrate just how mobile. In our research, we have found that 30% to 40% of samples of teachers drawn from the Web site have left the school. That search of the database would also show that there are many schools that were once active but no longer are, because of the departure or retirement of an active GLOBE teacher. An investment in supporting more consistent GLOBE implementation could better focus on improving ways to maintain contact with active teachers wherever they go; if there were truly "GLOBE teachers" rather than "GLOBE schools," the program could better facilitate teachers' taking the program to a new school.

To promote greater alignment, a focus on state standards and assignments might be a better investment of GLOBE's limited resources. There are examples of partnerships, such as GLOBE in Alabama, where the program has aligned with state systemic initiatives in mathematics and science education. These efforts to align GLOBE with state initiatives might result in better adoption rates and make more professional development funds available to GLOBE. To the extent that teacher mobility is lower across state boundaries, the high rate of teacher mobility would not hinder these efforts: teachers' curriculum would tend to be the same, as would GLOBE's alignment with local standards and assessments.

Recommendation 3: Give more time in teachers' initial training to helping teachers with facilitating data analysis activities with students.

Our student achievement study findings, combined with past data showing that only a third of teachers conduct data analysis activities with students, suggest that more time must be devoted to promoting data analysis activities in the classroom as part of teachers' initial protocol training. Our measures, even though they are closely aligned with GLOBE content, do measure skills that are typically tested on state and national assessments. Therefore, preparing teachers to teach these skills to students in the context of GLOBE not only would boost the Program's effectiveness, it could also boost students' performance on items that measure skill in reading and interpreting graphs and charts.

The Inquiry Workshop developed for GLOBE ONE provides activities and a model for how data analysis activities might better be promoted within the context of GLOBE implementation. The workshop included reviews of existing datasets and had a focus on how to promote student investigations. Disseminating this workshop model more broadly may help with improving students' opportunity to learn from participation in GLOBE activities; further, it may also help with improving data reporting levels, as indicated in our study of GLOBE professional development. The more emphasis partners reported giving to student inquiry, the more likely teachers were to report data to the GLOBE Web site.

Recommendation 4: Prioritize helping scientists meet educational outreach goals over advancing their research with student-collected data.

Despite the considerable resources devoted to GLOBE ONE, it is still unknown whether scientists are likely to meet the goal of publishing scientific papers that use student-collected data. Yet the emphasis within GLOBE thus far has been on attempting to balance science and education goals by having student-collected data contribute toward scientific advancement. Thus far, the primary evidence that student data can do so comes from studies focused on data quality (e.g., Robin, Levine, & Riha, 2005). However, student datasets in GLOBE have generally not been complete or accurate enough for scientists to use in their investigations.

From an educational outreach perspective, however, scientists' involvement has been especially rewarding for both scientists and educators. Scientists report that they enjoy their collaborations with schools, even though they are often time-consuming. Educators, particularly those in GLOBE ONE, were appreciative of the face-to-face contact they had with scientists and noted that their students were motivated by scientists' presence in the schools. Given that GLOBE's core mission will not change under NGG, science and education goals must still both be met; however, it may be much more viable for the Program to consider whether scientists' experience might prove more successful if the goal of their involvement focused on outreach rather than on advancing their own research with the help of students.

Recommendation 5: Plan for small experimental studies to measure GLOBE's effectiveness in the future.

The NGG White Paper calls for resources to be allocated such that the Program Office can "conduct both formative and summative evaluations on different aspects of the program to assess how effectively and efficiently NGG is being implemented, and what impact it is having in schools" (p. 7). In the past, NASA and the Program Office have sought to address evaluation needs through the conduct of large-scale studies of student achievement. The NASA Cooperative Agreement Notice, for example, called for a study of "at least 1000 students." SRI has sought to be responsive to these requests, but our experience suggests that such large numbers are neither necessary nor a cost-effective way to spend limited research funds, especially for the GLOBE Program.

The best way to estimate the sample size needed for a large-scale, experimental study is to conduct a statistical power analysis (Cohen, 1988). A power analysis includes several assumptions, including the likely magnitude of effects of the program and the degree to which students are "clustered" within classrooms. In our student achievement studies, when we have found positive effects, they have ranged widely from small, as was the case in this year's study, to moderate (roughly +0.50 standard deviation). This wide range suggests that more work may need to take place to specify an implementation fidelity model such that reliable effects can be achieved.

To develop such a model, several smaller-scale studies are likely to be necessary, in which students are assigned at random to different conditions. Random assignment is the best way to reduce threats to internal validity of studies (Shadish, Cook, & Campbell, 2002). If assignment happens at the level of students, then smaller-scale studies (of 50 to 100 students) have sufficient power to detect moderate effects of the Program. To be sure, the Program may need to oversee instruction directly for such studies, either by leading the activities or by partnering with a few local teachers on implementation. However, these studies would yield data on what aspects of GLOBE implementation ought to be “scaled up” and studied in a larger-scale randomized field trial because they (a) can be easily implemented and (b) produce at least moderate effects on student achievement.

There are two reasons why such research has not taken place as part of the evaluation activities to date, and both are important to consider before pursuing this course. First, the GLOBE Program itself has been reluctant to tell teachers how they should implement GLOBE. If NGG is not able to form such recommendations, it would not be wise to make the proposed investments in smaller-scale, well-controlled studies that SRI recommends. Even if NGG is willing to develop a model of implementation to promote with schools, a second hurdle must be overcome: the difficulty of promoting implementation. In our achievement studies—especially this year’s—we have found that teachers who plan to implement often decide not to do so, either because of time limitations or because program activities do not fit as well into their curriculum sequence as they had expected. GLOBE must improve the likelihood that its teachers who are trained in the Program will go on to implement it, and must provide the supports necessary to do so, before significant gains on achievement can be expected.

Evaluation is likely to be an area of continued importance within the GLOBE Program. After 10 years of serving as program evaluation partner for GLOBE, the team at SRI believes that the Program faces unique challenges to measuring implementation and outcomes for teachers and students that require considerable resources to overcome. We hope that the Program will find new sources of funding for evaluation to continue the quest to produce data that can guide improvements to the Program as we have done for the first 10 years of GLOBE.

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GLOBE Student Survey

Please use a black pen to complete this survey and mark an X in the box for the answer you choose. Please mark only ONE answer for each question unless the question gives you different instructions. If you make a mistake, put an "X" in the box for the answer you like best and then circle the box you really want.

1. Class Name:

2. Your grade (mark [X] one):

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12

3. Your age (mark [X] one):

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18

4. Your gender (mark [X] one):

☐ Male ☐ Female

5. Your ethnicity (mark [X] one):

☐ African-American ☐ Asian ☐ Hispanic/Latino ☐ Native American ☐ White ☐ Other

Please answer the questions beginning on the next page about your science class and GLOBE activities during this school year. Put an [X] in the box that best represents how often you do these science activities. For example, if you do something nearly everyday, put an [X] in the "Almost Everyday" column for that question.

6. About how often do you take part in the following types of activities in the science class you're in right now or as part of GLOBE?

	Never	1-3 times this school year	1-3 times a month	1-3 times a week	Almost everyday
a. Memorize basic facts and formulas that are in the textbook	☐	☐	☐	☐	☐
b. Do hands-on/laboratory activities	☐	☐	☐	☐	☐
c. Work on projects that take a week or more	☐	☐	☐	☐	☐
d. Suggest or help plan classroom investigations	☐	☐	☐	☐	☐
e. Collect and record data about the environment	☐	☐	☐	☐	☐
f. Look at the same data displayed in different ways (for example, table and graph)	☐	☐	☐	☐	☐
g. Identify possible causes of differences in data (for example, mistakes made in measuring something)	☐	☐	☐	☐	☐
h. Identify patterns in data and come up with explanations for them	☐	☐	☐	☐	☐
i. Write a report to explain your thinking or reasoning about data you have collected	☐	☐	☐	☐	☐

7. About how often have you studied the following ideas about atmosphere as part of this science class this year? Mark one box [X] to the right of each concept listed below.

	Not at all	1 to 5 class periods	More than 5 class periods
a. Clouds	☐	☐	☐
b. Precipitation	☐	☐	☐
c. Precipitation pH	☐	☐	☐
d. Temperature	☐	☐	☐
e. Weather and Climate	☐	☐	☐

8. How much time do you spend each week doing science homework or learning about science when you're not at school? Mark an [X] in the box that most closely estimates the amount of time you spend.

Not at all	1 hour or less	More than 1 hour
☐	☐	☐

9. **How often have you done each of the following GLOBE activities during this school year? Mark answers with an [X].**

	Never	1-3 times this school year	1-3 times a month	1-3 times a week	Almost everyday
a. Taken measurements using GLOBE protocols	☐	☐	☐	☐	☐
b. Used a computer to enter GLOBE data into the GLOBE Student Data Archive	☐	☐	☐	☐	☐
c. Talked about GLOBE data that you or other students collected	☐	☐	☐	☐	☐
d. Conducted an analysis or solved a problem using GLOBE data	☐	☐	☐	☐	☐
e. Answered a question that you chose using GLOBE data	☐	☐	☐	☐	☐
f. Participated in a GLOBE learning activity	☐	☐	☐	☐	☐

10. **How often have you done protocols from each of the following GLOBE investigation areas during this school year? Mark answers with an [X].**

	Never	1-3 times this school year	1-3 times a month	1-3 times a week	Almost everyday
a. Atmosphere/Climate *(such as cloud cover, precipitation, current temperature, maximum and minimum temperature)*	☐	☐	☐	☐	☐
b. Hydrology *(such as water temperature, pH, transparency, dissolved oxygen, electrical conductivity, salinity, alkalinity, nitrate)*	☐	☐	☐	☐	☐
c. Soil *(such as measuring soil moisture and temperature, and characterizing soil features including structure, color, and texture)*	☐	☐	☐	☐	☐
d. Land Cover/Biology *(such as GPS location, MUC classification, biometry measurements)*	☐	☐	☐	☐	☐
e. Phenology *(such as measuring when buds appear on plants in the spring and when leaves fall in the autumn)*	☐	☐	☐	☐	☐

- - -

Please answer the following questions about your opinions regarding your science class and the GLOBE program. Please indicate how much you agree or disagree with each statement and mark an [X] in the appropriate box. For example, if you do not agree at all, put an [X] in the "Strongly disagree" box for that question.

11. About how often do you take part in the following types of activities in the science class you're in right now or as part of GLOBE?

	Strongly disagree	Disagree	Agree	Strongly agree
a. It's important to me that I learn a lot of new concepts in science this year.	☐	☐	☐	☐
b. I don't like to learn a lot of new concepts in class.	☐	☐	☐	☐
c. One of my goals in class is to learn as much as I can.	☐	☐	☐	☐
d. It's important to me that I thoroughly understand my classwork.	☐	☐	☐	☐
e. I can do almost all the work in class if I don't give up.	☐	☐	☐	☐
f. Even if the work is hard, I can learn it.	☐	☐	☐	☐
g. I can do even the hardest work in class if I try.	☐	☐	☐	☐
h. GLOBE is fun.	☐	☐	☐	☐
i. I look forward to GLOBE activities in class.	☐	☐	☐	☐
j. I like measuring things in science class.	☐	☐	☐	☐

12. Last year, I was one of the best students in my science class.

Strongly disagree	Disagree	Agree	Strongly agree
☐	☐	☐	☐

13. Last year in science, I made:

Ds & Fs	Cs & Ds	Bs & Cs	Mostly or all As
☐	☐	☐	☐

14. Last year, I thought science was:

- ☐ The hardest subject for me to do well.
- ☐ More difficult than some subjects for me to do well.
- ☐ Easier than some subjects for me to do well.
- ☐ The easiest subject for me to do well.

Thank you for participating in this GLOBE survey.

ASSESSMENT OF STUDENT LEARNING

Section A: Atmosphere Questions

Instructions

On the following pages, you will be asked several questions about topics you may have studied in science this year. Some of the questions may be difficult for you, but do the best you can to answer each question correctly. Where appropriate, circle the letter next to the correct answer or write in complete sentences.

1. What is the difference between what scientists call the weather in a region and that region's climate?

____

____

____

____

____

____

____

2. A road is made of black asphalt. The sidewalk next to the road is made of light gray concrete. On a bright, sunny day, which surface would get hotter and why? (Circle one)

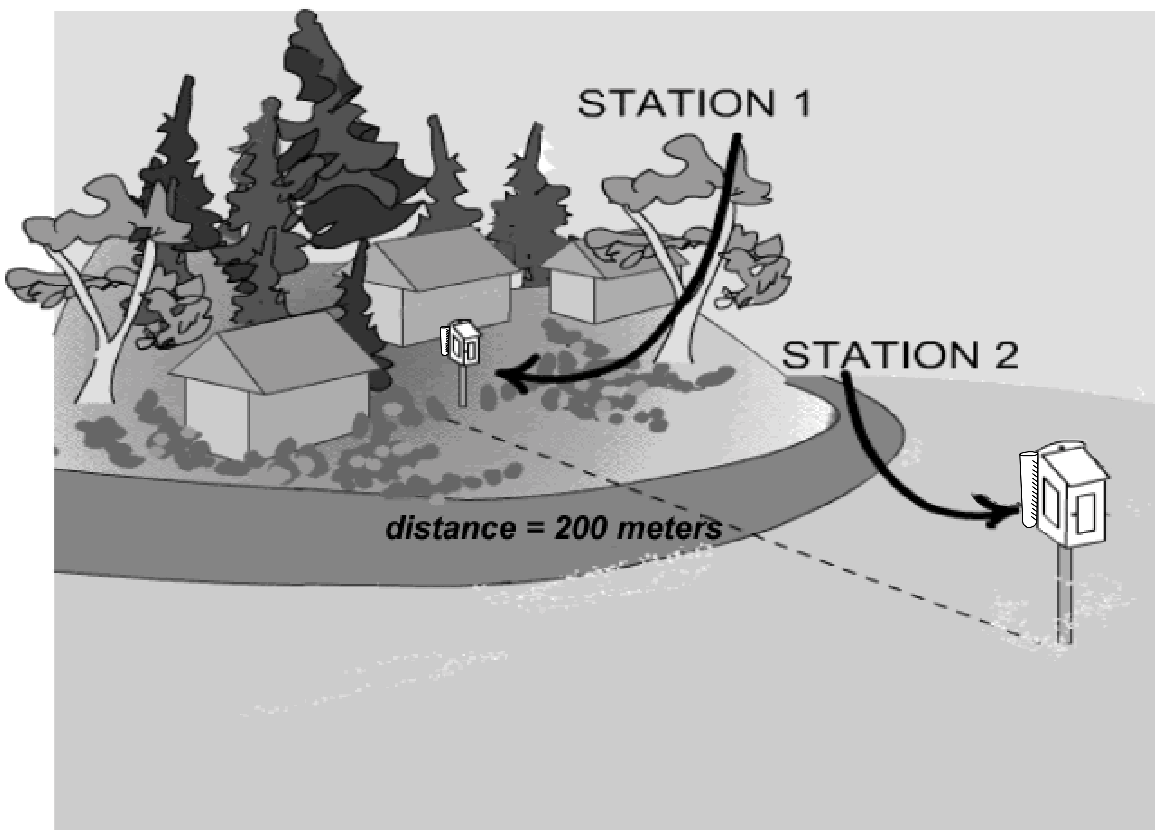
A. The road because dark materials hold heat longer once they are heated.

B. The sidewalk because it reflects more sunlight.

C. The sidewalk because light-colored materials are more easily heated.

D. The road because dark materials absorb more heat energy.

3. The National Weather Service has decided to move the thermometer and rain gauge that meteorologists use to measure temperature and record precipitation. Scientists are planning to move the station just 200 meters away from its original location (see picture below). The meteorologists are concerned about the impact of a different location on the measurement of daily temperature and rainfall. What could the scientists do to test whether there is a difference in measured daily temperature and rainfall between the old and new locations?



4. When John first got up in the morning, he noticed that the outside temperature was 17 degrees C. That day at school his lab group recorded the air temperature at solar noon to be 20 degrees C. What would explain the measured increase in temperature? (Circle one)

   A. Air molecules lose their moisture due to the sun.

   B. Air molecules gained energy from the earth's surface because of the sun's heat.

   C. Air molecules caused atmospheric pressure to increase.

   D. Air molecules mix with particles and become polluted.

5. Why is it important to calibrate the Maximum/Minimum Thermometer at least every three months? (Circle one)

   A. To be sure the temperature measurement is accurate.

   B. Because the climate is changing

   C. To adjust to the change of the seasons.

   D. To be sure the shelter is positioned properly.

6. What two gases make up 99 percent of the composition of the atmosphere?

7. The clouds shown in the picture below are best classified as: (Circle one)

A. Stratus

B. Stratocumulus

C. Cirrus

D. Altostratus

8. What would be the best estimate for cloud coverage in the picture below? (Circle one)

A. 20%

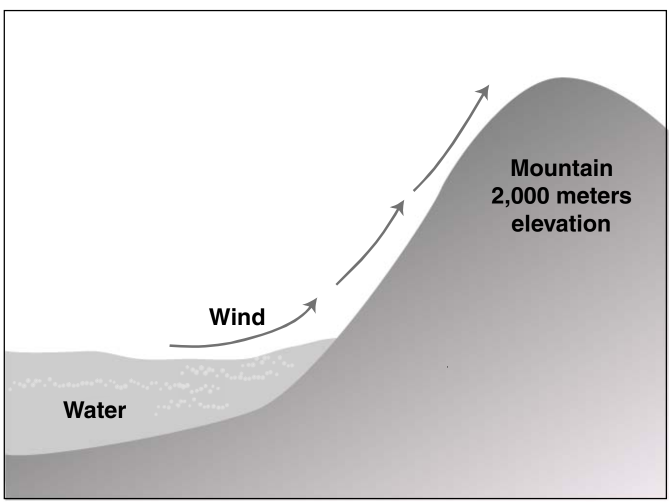
B. 50%

C. 70%

D. 90%

9. What determines whether clouds have a cooling or warming effect on the atmosphere at the Earth's surface?

10. As moist air moves and rises over the mountain in this picture, what would you expect to happen? (Circle one)



A. As the air rises over the mountain, it cools and clouds may form.

B. The air is blocked by the mountain and becomes warmer.

C. The air goes up and over the mountain with no change.

D. The air warms up and keeps rising after passing the mountain.

Questions 11-14 are based on Figures 1 and 2, below. Each figure represents a different projection of global atmospheric carbon dioxide levels (in parts per million). The two estimates were produced by different research laboratories.

Figure 1. Center for Atmospheric Studies' projection of global atmospheric CO_2 levels (ppm)

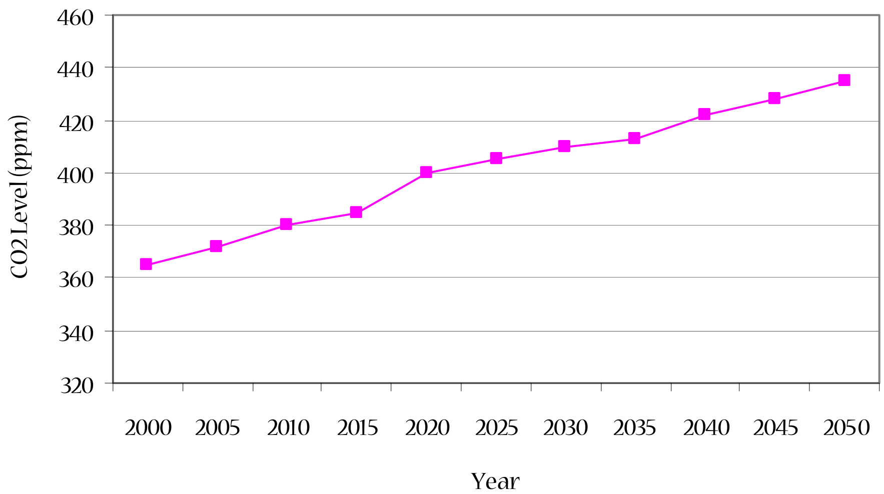
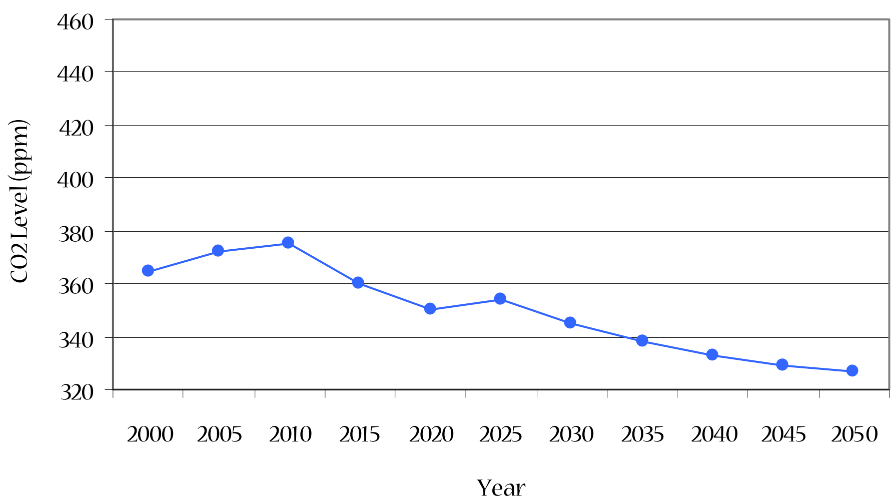


Figure 2. Institute for Environmental Studies' projection of global atmospheric CO_2 levels (ppm)



11. What is the difference between the Center for Atmospheric Studies' projection of the carbon dioxide level in 2015 and the Institute for Environmental Studies' prediction? (Circle one)

A. 0 ppm

B. About 22 ppm

C. About 100 ppm

D. About 48 ppm

12. Which statement about trends in the data from the figures above is true? (Circle one)

A. In 2000, the carbon dioxide level in the atmosphere is much higher in Figure 1 than in Figure 2.

B. In 2030, the carbon dioxide level in the atmosphere is higher in Figure 2 than in Figure 1.

C. Carbon dioxide levels in the atmosphere are increasing over time in Figure 1.

D. Carbon dioxide levels in the atmosphere are increasing over time in Figure 2.

13. A group of students looking at the data from Figure 2 think that the projections show changes in humans' impact on the atmosphere. What changes in human activities between 2000 and 2050 could account for the declining trend in Figure 2?

14. From Figure 1, would you expect global temperature near the Earth's surface to increase, decrease, or stay the same between 2000 and 2050? Explain your answer.

Section B: Snow Days Task

Instructions

Every year, many schools in the United States close because of snow. If there are too many snow days, then schools often stay open in May or June much later than planned.

This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland.

You will be asked to answer several questions to help you complete your task using scientific data about the climate of the four cities. By answering each of questions that follow, you will:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

You will use your work to help you answer the last part of this task.

Note: The same instructions appear on each page, to remind you of the overall goal for the task.

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

1. A group of students from last year worked on the same snow problem. That group believed you would need to answer each of the questions below in order to help predict how many snow days the districts should expect each winter.

   Circle the letter next to each question YOU think must be answered to make a good prediction about how many snow days the four cities can expect each winter. (Circle all that apply)

   A. Why do some students prefer snow days to getting out of school in time in the spring?

   B. Why is the number of snow days so hard to predict?

   C. On average, how many days does it snow each year?

   D. Does it snow often when school is not in session, such as during winter break?

   E. What do teachers think about snow days?

   F. About how long does snow usually stay on the ground and keep schools closed?

2. Choose one of the answers that you did NOT select above. Explain why an answer to that question is NOT relevant to your task.

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

3. To make a prediction about how many snow days the cities can expect each winter, you will need to study climate data from each of the four cities (Detroit, Louisville, Raleigh, Portland).

   Which of the following data sets would be the best data set to choose? (Circle one)

   A. Average number of cloudy days
   B. Average high temperature in winter
   C. Average amounts of liquid precipitation
   D. Average number of days with solid precipitation on the ground
   E. Average low temperature in winter

4. What instruments would you use to collect these data? (Circle one)

   A. Clinometer and snowboard
   B. Max-min thermometer, pH paper, and densiometer
   C. Rain gauge, meter stick, and snowboard
   D. Max-min thermometer, cloud observation chart, and rain gauge
   E. Cloud observation chart and meter stick

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

5. In January 1977, Portland moved its weather station from one part of the airport to another part. The elevation of the new station is 1.5 m closer to sea level. What other features of the new site of the weather station might affect temperature and snowfall measurements?

6. If the new location of the weather station is less exposed to direct sunlight, how would the measurements of temperature and solid precipitation be different at the new location?

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

7. The two tables below show two different sets of snow measurements. Table A shows the number of days in January 1996 when 200 mm or more new snow fell from the sky. Table B shows the number of days in January 1996 when 200 mm or more snow was on the ground (snow depth).

Table A. Number of days when 200 mm or more new snow fell

	Jan 1996
Detroit	6
Louisville	4
Raleigh	2
Portland	1

Table B. Number of days when snow depth on the ground was 200 mm or more

	Jan 1996
Detroit	18
Louisville	7
Raleigh	5
Portland	2

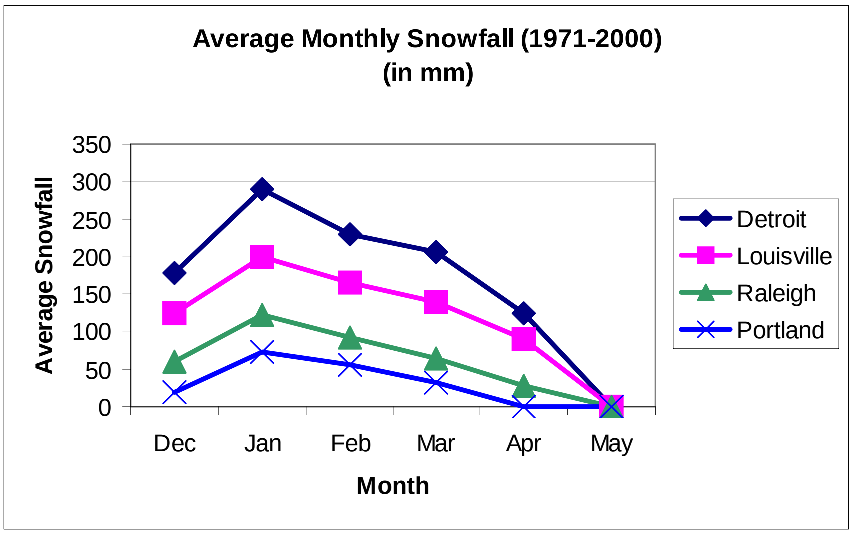
Look at the data for January in both tables. What might be a reason for the difference in the number of days recorded for the amount of new snow that fell and the depth of snow on the ground?

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

Use Chart A to answer questions 8–10.

Chart A



8. Which city averages the least amount of snowfall in February? (Circle one)
   A. Detroit
   B. Portland
   C. Raleigh
   D. Louisville

9. On average, during what month do these United States cities record the most snowfall? (Circle one)
   A. December
   B. January
   C. February
   D. March

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

10. During which month would you least expect there to be any snow days for Detroit? (Circle one)

A. December

B. March

C. April

D. May

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

Use Tables C and D to answer questions 11–12.

Table C. Number of days with 200 mm or more snow depth, by year (1987–97)

	1987–88	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
Detroit	13	4	1	1	0	9	10	1	25	10
Louisville	11	7	4	0	0	5	3	0	10	3
Raleigh	7	6	3	0	0	4	0	1	9	0
Portland	8	1	0	2	0	1	1	0	2	0

Table D. Number of days with 200 mm or more snow depth in 1995–96

	Dec	Jan	Feb	Mar	Apr	May
Detroit	0	18	6	1	0	0
Louisville	0	7	3	0	0	0
Raleigh	0	5	4	0	0	0
Portland	0	2	0	0	0	0

11. Which of the following statements about the data in Tables C and D is true? (Circle one)

    A. There were 0 days in 1994–95 when snow depth in Raleigh was 200 mm or more.

    B. Raleigh had fewer days than Louisville when snow depth was 200 mm or more in February 1995– 96.

    C. Raleigh had more days than Detroit when snow depth was 200 mm or more in 1987–88.

    D. Raleigh had more days when snow depth was 200 mm or more in 1995–96 than in any other year from 1987 to 1997.

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

12. The Raleigh school district often closes schools when snow depth is 200 mm or more.

Carmen thinks that Raleigh should plan for 3 snow days a year. She notes that from 1987 to 1997, on average, the Raleigh region had 3 days per winter when the snow depth was 200 mm or more.

Yolanda thinks that Raleigh should plan for 9 snow days a year. She notes that in 1995-96, on average, the Raleigh region had 1.5 days per winter month when the snow depth was 200 mm or more.

Who do you think is more likely to be right, Carmen or Yolanda? Explain in detail why you think so.

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

13. Use Table E to solve the following problem. Calculate the average number of days per year with 200 mm or more of snow depth for Louisville between 1987-88 and 1996-97.

Table E. Number of days with 200 mm or more snow depth, by year (1987–97)

	10-yr avg.	1987–88	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
Detroit	7.4	13	4	1	1	0	9	10	1	25	10
Louisville		**11**	**7**	**4**	**0**	**0**	**5**	**3**	**0**	**10**	**3**
Raleigh	3.0	7	6	3	0	0	4	0	1	9	0
Portland	1.5	8	1	0	2	0	1	1	0	2	0

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

14. Between 1987 and 1997, Detroit got snow when school wasn't usually in session, during the winter break. On average, there were 1.1 days per year when snow depth in Detroit was 200 mm or more during the holiday break.

    Using the data in Table E and the information about snow depth during holiday break, calculate how many snow days Detroit should expect each year. (Assume that, like Raleigh, Detroit closes schools when snow depth is 200 mm or more.)

Your Task: This year, imagine that you have been asked to help four school districts in four large cities in the United States to predict how many snow days they can expect each year. The cities are Detroit, Louisville, Raleigh, and Portland. You have to:

1. Develop an approach to the problem.
2. Analyze data.
3. Use your data analysis to predict the number of snow days to expect each year.

15. Write a paragraph to the Department of Public Instruction in Portland recommending the number of snow days that Portland should expect each year. Your paragraph should begin with a complete sentence stating how many snow days, on average, Portland can expect.

    Next, describe the procedure you used to make your prediction: state the reasons behind your recommendations, using data from tables on the previous pages.

    You should also note in your paragraph any other variables that could affect your recommendations. Use the questions on the previous pages as clues to identify some of these variables. (Assume that Portland closes schools when snow depth is 200 mm or more.)

Dear Department of Public Instruction,

Week ending: ☐☐ / ☐☐ / ☐☐ (mm / dd / yy)

Weekly Activities Log

Teacher ID: 101 - 1

Number of classes covered in this log *(mark applicable number and enter all names below)*:

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

Teacher Name: GLOBE Teacher

School: GLOBE Test School

Class Name(s): ☐

Using BLACK ink, please mark (X) boxes and enter numbers as appropriate to indicate the GLOBE activities you conducted with your students this week.

GLOBE Protocols conducted

☐ Yes ☐ No

Mark all protocols that apply:

- ☐ Clouds
- ☐ Precipitation
- ☐ Relative Humidity
- ☐ Max/Min/Current Air Temperature
- ☐ Other Atmosphere protocol(s)
- ☐ Other GLOBE investigation area protocol(s)

GLOBE Learning Activities conducted

☐ Yes ☐ No Number conducted: ☐☐

Mark all learning activities that apply:

- ☐ Observing, Describing, and Identifying Clouds
- ☐ Estimating Cloud Cover
- ☐ Cloud Watch
- ☐ Studying the Instrument Shelter
- ☐ Building a Thermometer
- ☐ Draw Your Own Data Visualization
- ☐ Other Atmosphere Learning Activity(ies)
- ☐ Other Investigation Area Learning Activity(ies)

Data Entry? ☐ Yes ☐ No Number of students involved: ☐☐

Topics Covered (mark all that apply)

How Topics Were Covered:	Clouds	Precipitation	Precipitation pH	Temperature	Weather and Climate
My students memorized facts or definitions on this topic.	☐	☐	☐	☐	☐
My students made observations or took measurements related to this topic.	☐	☐	☐	☐	☐
My students generated scientific explanations of data related to a complex phenomenon.	☐	☐	☐	☐	☐
My students explored patterns in data or analyzed data.	☐	☐	☐	☐	☐
My students made inferences and predictions from data.	☐	☐	☐	☐	☐
My students read in a book or listened to material on this topic.	☐	☐	☐	☐	☐
My students used computers to explore this topic.	☐	☐	☐	☐	☐

Comments:

SRI Use Only: ☐☐☐

46892

Week ending: __ __ / __ __ / __ __
mm dd yy

Weekly Activities Log

Teacher ID: 1 0 1 - 1

Number of classes covered in this log *(mark applicable number and enter all names below)*:

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

Teacher Name: GLOBE Teacher

School: GLOBE Test School

Class Name(s):

	Topics Covered (mark all that apply)				
How Topics Were Covered:	**Clouds**	**Precipitation**	**Precipitation pH**	**Temperature**	**Weather and Climate**
My students memorized facts or definitions on this topic.	☐	☐	☐	☐	☐
My students made observations or took measurements related to this topic.	☐	☐	☐	☐	☐
My students generated scientific explanations of data related to a complex phenomenon.	☐	☐	☐	☐	☐
My students explored patterns in data or analyzed data.	☐	☐	☐	☐	☐
My students made inferences and predictions from data.	☐	☐	☐	☐	☐
My students read in a book or listened to material on this topic.	☐	☐	☐	☐	☐
My students used computers to explore this topic.	☐	☐	☐	☐	☐

Please mark (X) boxes and enter numbers as appropriate to indicate the GLOBE activities, if any, you conducted with your students this week.

GLOBE Protocols conducted

☐ Yes ☐ No

Mark all protocols that apply:

- ☐ Clouds
- ☐ Precipitation
- ☐ Relative Humidity
- ☐ Max/Min/Current Air Temperature
- ☐ Other Atmosphere protocol(s)
- ☐ Other GLOBE investigation area protocol(s)

GLOBE Learning Activities conducted

☐ Yes ☐ No Number conducted: __ __

Mark all learning activities that apply:

- ☐ Observing, Describing, and Identifying Clouds
- ☐ Estimating Cloud Cover
- ☐ Cloud Watch
- ☐ Studying the Instrument Shelter
- ☐ Building a Thermometer
- ☐ Draw Your Own Data Visualization
- ☐ Other Atmosphere Learning Activity(ies)
- ☐ Other Investigation Area Learning Activity(ies)

Data Entry? ☐ Yes ☐ No Number of students involved: __ __

Comments:

SRI Use Only:

29679

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OMB No. 2700-0114
Approval expires April 30, 2007

A SURVEY OF GLOBE PARTNERS

For questions regarding this survey, contact Amy Lewis at 1 (800) 682-9308.

Please use a black pen; pencils or red and blue pens cannot be read by our scanners. When asked to mark boxes, make an "X" through the boxes. If you need additional space to respond to a question, use the box on the back of the survey to continue your response (please write the number of the question next to your response).

29679

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Name of partnership: Partnership name (merged)

First name | **Last name**

Your position/title:

Date: __ __ / __ __ / __ __
m m d d y y

A. YOUR PARTNERSHIP

A1. What do you see as the primary mission of your GLOBE partnership?

A2. What benefits do you see in participating in the GLOBE program as a partner?

A3. How important is each of the following activities to the work of your partnership?
Mark (X) one for each line.

	Not at all important	Somewhat important	Very important
a. Recruiting new teachers to GLOBE	☐	☐	☐
b. Training new GLOBE teachers	☐	☐	☐
c. Providing mentoring and support to teachers or schools after training	☐	☐	☐
d. Building community involvement in GLOBE	☐	☐	☐
e. Participating in GLOBE professional development activities	☐	☐	☐

A4. Has anyone in your partnership or anyone you work with (colleagues, science partners, etc.) been involved in developing your state/regional/national science curriculum standards?

☐ Yes ☐ No

A5. Has GLOBE been integrated into any of your state/regional/national standards? *Mark (X) all that apply.*

☐ Science ☐ Mathematics ☐ Other *Please describe:*

B. COMMUNITY PARTICIPATION

B1. Is your partnership actively involved with local community organizations?

☐ Yes ☐ No

B2. What successes or barriers have you encountered in initiating involvement with community organizations?

B3. What can GLOBE do to help your partnership develop or enhance your GLOBE Learning Community (GLC)*?

☐ Share successful models of GLCs

☐ Provide assistance with proposal development

☐ Provide networking opportunities

☐ Other *Please describe:*

If you answered "Yes" to question B1, continue with the next question.
If you answered "No" to question B1, skip to Section C.

B4. Please list the three community organizations that have provided the most support to your partnership.
Print names of supporting organization(s) and enter organization type codes from the list below.

1. Type:
2. Type:
3. Type:

A Science centers/museums
B Parks/recreation facilities
C Youth organizations
D Senior centers/organizations
E Universities/colleges
F School districts
G Churches, synagogues, or other religious organizations
H Local government agencies
I Agricultural organizations
J Environmental organizations
K Other *(Specify in name box.)*

*A GLC is a group of diverse organizations with broad expertise and resources, who share a commitment to supporting teachers and students in implementing GLOBE for the benefit of their community.

B5. What types of support have the three organizations you listed in B4 provided? *Mark (X) all that apply for each organization.*

How help is provided:

- **a** Recruitment assistance
- **b** Training assistance
- **c** GLOBE equipment
- **d** Volunteer data collectors
- **e** Volunteer data reporters
- **f** Classroom assistance
- **g** Transportation
- **h** Media coverage
- **i** Funding
- Other *Please explain in appropriate box(es) below.*

	a	b	c	d	e	f	g	h	i	*Other, please explain:*
Organization 1:	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Organization 2:	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Organization 3:	☐	☐	☐	☐	☐	☐	☐	☐	☐	

C. TRAINERS AND TRAINER SUPPORTS

C1. What are the affiliations of your trainers who have attended a Train-the-Trainer (TTT) session in the past 3 years? *Note how many of these trainers are from each of the following types of institutions (the primary institution they work with). Count each trainer only once.*

College or University Faculty		Primary/Secondary Schools		Other Affiliations (Please specify.)	
Education department	☐☐	Elementary school	☐☐		☐☐
Science department	☐☐	Middle school	☐☐		☐☐
Other departments	☐☐	High school	☐☐		☐☐
		Other K-12	☐☐		

C2. By what means might GLOBE provide learning opportunities to meet the needs of trainers in your partnership?

☐ Online
☐ Face-to-face
☐ Video conferencing
☐ Other *Please specify:*

D. GLOBE TRAINING

The following questions refer to GLOBE trainings you offered during the past year (June 1, 2003 - May 31, 2004).

D1. How long was the typical GLOBE training offered by your partnership in the last year (June 1, 2003 - May 31, 2004)?

a. If the typical training was offered in a SINGLE session, enter the length of that session in hours below and proceed to question D2. If the training was offered in multiple sessions, go to D1b.

Number of training hours: ☐☐☐

b. If the typical training was offered in MULTIPLE sessions, enter the number of days on which training took place and the average length of each day's training in hours.

Number of training days: ☐☐ Average number of training hours per day: ☐☐

D2. How much time was devoted to each of the following topics during a typical GLOBE training your partnership offered in the last year? *Mark one for each line.*

		No time	Less than 1 hour	1 - 3 hours	More than 3 hours
a.	Atmosphere protocols	☐	☐	☐	☐
b.	Atmosphere learning activities	☐	☐	☐	☐
c.	Hydrology protocols	☐	☐	☐	☐
d.	Hydrology learning activities	☐	☐	☐	☐
e.	Land Cover/Biology protocols	☐	☐	☐	☐
f.	Land Cover/Biology learning activities	☐	☐	☐	☐
g.	Soil protocols	☐	☐	☐	☐
h.	Soil learning activities	☐	☐	☐	☐
i.	Earth as a System protocols	☐	☐	☐	☐
j.	Earth as a System learning activities	☐	☐	☐	☐
k.	GPS	☐	☐	☐	☐
l.	Hands-on practice using GLOBE data reporting forms	☐	☐	☐	☐
m.	Hands-on practice using GLOBE data visualizations	☐	☐	☐	☐
n.	Use of inquiry with GLOBE data	☐	☐	☐	☐
o.	Ways to integrate inquiry into the classroom	☐	☐	☐	☐
p.	Ways to integrate GLOBE with state/regional/national standards	☐	☐	☐	☐
q.	Ways to integrate GLOBE with teachers' curricula	☐	☐	☐	☐
r.	Implementation planning	☐	☐	☐	☐
s.	Mentoring/feedback on implementation steps taken between training sessions	☐	☐	☐	☐

Please add any other important topics:

D3. In your trainings in the last year (June 1, 2003 - May 31, 2004), did you discuss or provide materials in any of the following ways? *Mark (X) all that apply.*

- ☐ Introduce teachers to the structure of the GLOBE Teacher's Guide (e.g., use of "grey boxes" and "Looking at the Data" sections to support protocols and learning activities)
- ☐ Use online GLOBE resources *Specify which resources:* ________
- ☐ Review one or more sections of the GLOBE Teacher's Guide
- ☐ Provide tips on use of materials
- ☐ Provide supplementary or tailored materials (e.g., additional activities to build on a GLOBE learning activity, or a modification of a GLOBE learning activity)
- ☐ Discuss integration or inclusion of other curricula (e.g., Project WET, FOSS, etc.)

D4. a. In your trainings in the last year, did you include time helping teachers to integrate GLOBE into the curriculum, as opposed to doing GLOBE as a stand-alone activity?

☐ Yes ☐ No

b. If yes, did you use any of the following instructional approaches to support the goal of curriculum integration? *Mark (X) all that apply.*

- ☐ Discuss alignment of GLOBE with state/regional/national standards
- ☐ Provide examples of alignment of GLOBE with state/regional/national standards
- ☐ Engage teachers in aligning GLOBE activities with their state/regional/national standards
- ☐ Review the examples of GLOBE alignment with standards provided on the GLOBE Web site (see "Learning Standards" under the "Educators' Corner" side bar link)
- ☐ Present examples or information on ways to integrate GLOBE with teachers' own curriculum or classroom activities
- ☐ Engage teachers in discussing how they might integrate GLOBE with their own curriculum or classroom activities
- ☐ Present tips on ways to tailor GLOBE to the local environment/students' needs (e.g., use GLOBE activities to familiarize students with local environmental features)
- ☐ Engage teachers in tailoring GLOBE to their local environment/students' needs
- ☐ Demonstrate the links between data analysis activities and the mathematics curriculum
- ☐ Discuss how data sets (GLOBE or other) can be used to illustrate mathematical concepts
- ☐ Discuss the scientific significance of students' data collection activities
- ☐ Discuss GLOBE integration with other content areas, such as Technology, Language Arts or Social Studies. *Specify which areas below:*

____

D5. a. Has your partnership attempted to tailor or localize GLOBE activities to increase their relevance to students from underrepresented groups? ***(Groups underrepresented in science and mathematics careers typically include women, individuals with special needs, and minorities.)***

☐ Yes ☐ No

b. If "Yes," please describe how GLOBE activities have been made more relevant.

D6. a. In your most recent training, did you spend time on ways to promote student inquiry* within GLOBE activities? (See definition of inquiry in footnote below.)

☐ Yes ☐ No ***Skip to Section E.***

b. If yes, did you use any of the following instructional approaches to support the goal of student inquiry?* *Mark (X) all that apply.*

- ☐ Use information in the Teacher's Guide *If yes, specify which sections below:*
  - ☐ Implementation Guide
  - ☐ Field/Lab Guides
  - ☐ At a Glance/Welcome overviews
  - ☐ Protocols
  - ☐ Data Sheets
  - ☐ Looking at the Data
  - ☐ Learning Activities
  - ☐ Toolkit
  - ☐ Other *Specify:*
- ☐ Formulating scientific questions
- ☐ Making predictions about data they are collecting
- ☐ Monitoring the accuracy of their data collection activities
- ☐ Finding trends and patterns in data
- ☐ Interpreting data
- ☐ Developing presentations of their findings
- ☐ Review the inquiry section in the GLOBE Implementation Guide available online
- ☐ Show teachers how to introduce GLOBE according to their students' knowledge and experience (i.e., using the beginner, intermediate, advanced sequencing provided in the Teacher's Guide)
- ☐ Discuss how data from protocols can be used to support student inquiry
- ☐ Discuss how to help students use data as a source of knowledge about a local issue
- ☐ Offer examples of successful student inquiry projects that teachers might consider adopting or adapting
- ☐ Engage teachers in an inquiry activity during the training that goes through all the steps (develop a hypothesis, plan the investigation, collect and analyze data)
- ☐ Model specific steps of using scientific inquiry in the classroom during the training
- ☐ Use of other instructional materials *Please specify below:*

*Inquiry involves making observations; posing questions; learning what is already known; planning investigations; using tools to gather, analyze, and interpret data; proposing predictions and explanations; and communicating results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.

E. TEACHER SUPPORT PRACTICES

E1. Which areas of support has your GLOBE partnership provided for those who have completed teacher training, and how is the support allocated? *Mark (X) one for each line.*

	Provided to everyone	Provided to all who request it	Provided as budget allows	Not provided
a. Provide GLOBE equipment	☐	☐	☐	☐
b. Provide computers and technology (e.g., Internet connection)	☐	☐	☐	☐
c. Monitoring the accuracy of their data collection	☐	☐	☐	☐
d. Assistance on technical setup and equipment use	☐	☐	☐	☐
e. Funding for administration and overhead	☐	☐	☐	☐
f. Funding for programmatic activities	☐	☐	☐	☐
g. Incentives in return for reporting certain types or amounts of data	☐	☐	☐	☐
h. Monitoring and feedback on data reporting contributions	☐	☐	☐	☐
i. Refresher training sessions	☐	☐	☐	☐
j. Meetings, conferences to share GLOBE experiences	☐	☐	☐	☐
k. Teacher listserv	☐	☐	☐	☐
l. Supplemental materials (e.g., implementation tips, additional learning activities)	☐	☐	☐	☐
m. Alignment of GLOBE activities with state or local curriculum or accountability requirements	☐	☐	☐	☐
n. Site visits by partnership staff or mentor teachers	☐	☐	☐	☐
o. Personal contact with partnership staff or mentor teachers through phone or email	☐	☐	☐	☐
p. Contacts with scientists	☐	☐	☐	☐

Please describe other supports provided:

E2. Please tell us about any creative support strategies you've used that might be of value to other partners:

E3. How do you fund your follow-up activities currently? *Mark (X) all that apply.*

- ☐ Federal grants
- ☐ State grants
- ☐ Corporate foundation grants
- ☐ Public/community foundation grants
- ☐ Fees
- ☐ Individual donations
- ☐ Sponsorships
- ☐ Other *Please specify:*
- ☐ We have been unable to conduct follow-up activities.
- ☐ We have been unable to raise funds for follow-up activities.

E4. How do you monitor ongoing participation of GLOBE schools and teachers in the program?
Mark (X) all that apply.

- ☐ Use Partner Administration pages of the GLOBE Web site to view school reporting activity
- ☐ Email contact with teachers
- ☐ Telephone contact with teachers
- ☐ Teacher surveys
- ☐ Visit school/teacher
- ☐ Participation is not monitored by the partnership at this time
- ☐ Other *Please specify:*

E5. How do you usually find out about challenges teachers have with implementing GLOBE and reporting data?

a. Mark (X) all methods that apply.

- ☐ When they call or email me
- ☐ When I call or email them
- ☐ When I visit their school
- ☐ When they come back for refresher training
- ☐ When I review their data from the Web site
- ☐ I hardly ever hear about challenges
- ☐ Other *Please specify:*

b. Which of these methods is the most frequent?
Mark (X) only one.

- ☐ When they call or email me
- ☐ When I call or email them
- ☐ When I visit their school
- ☐ When they come back for refresher training
- ☐ When I review their data from the Web site
- ☐ Other *Please specify:*

F. PROMOTING STUDENT RESEARCH

F1. What might the GLOBE Program office do to help facilitate school-to-school collaboration?

F2. How might the GLOBE Program office better support student research using GLOBE data?

G. PERSPECTIVES

G1. What might be provided on the GLOBE Web site to help you design and implement more effective teacher training sessions?

G2. What constructive feedback are you getting from teachers about the GLOBE Teacher's Guide and other GLOBE materials that can guide future revisions and/or development?

29679

G3. Which method would you prefer for receiving communications from GLOBE regarding materials, the GLOBE Web site, and/or training updates? *Mark (X) only one.*

- ☐ GLOBE Web site
- ☐ Partner listserv
- ☐ Meetings/conversations with individual GLOBE staff
- ☐ GLOBE Annual Conference
- ☐ Other *Please specify:*

G4. Which sections of the Partner Administration pages of the Web site do you use? *Mark all that apply.*

- ☐ Partnership Profile
- ☐ Schools in my Region
- ☐ Support Materials
- ☐ Workshop Administration
- ☐ GLOBE Communities
- ☐ GLOBE Calendar
- ☐ I haven't used the Partner Administration pages ***Skip to question G6.***

G5. What can we do to improve the GLOBE Partner Administration pages?

G6. What single improvement could GLOBE make to significantly increase its effectiveness?

29679

If you have any further comments, or need to continue a response to a previous question, please use the space below.

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

Please use the enclosed business reply envelope to return the survey to the address below:

GLOBE Evaluation
SRI International
333 Ravenswood Avenue, BN 319
Menlo Park, CA 94025

OMB No. 2700-0114
Approval expires April 30, 2007

GLOBE Teacher Survey on Professional Development (2005)

For questions regarding this survey, contact Christine Korbak at 1 (800) 682-9308.

The survey you are about to complete is designed to provide a detailed description of your experiences in professional development with the GLOBE Program from May 2003 to April 2005. We will begin by asking about the entire variety of GLOBE-related professional development in which you participated and then switch to focus on just one of those professional development experiences for the remainder of the survey.

Please make certain that your answer refers to the professional development experience being asked about in each question.

We have tested this survey with some teachers, and they took about 30 minutes to complete it. You may want to complete parts of the survey at different times when you have a few minutes. Please indicate all responses by writing an "X" or a number in the appropriate boxes (☐) or writing short statements where requested. Use a black pen; pencils or red and blue pens cannot be read by our scanners.

Part I: Your Overall GLOBE Professional Development

1. This first question is about *your first protocol training* in GLOBE. Where did you attend your first protocol training?

City: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

State: ☐☐

2. Was your protocol training part of one of the following? (Mark [X] one box.)

- ☐ a. An in-district workshop or institute
- ☐ b. A college course
- ☐ c. An out-of-district workshop or institute
- ☐ d. An out-of-district conference (e.g., a state or national science teachers' conference)
- ☐ e. Other (please specify): ______

3. In addition to your initial protocol training, which of the following kinds of professional development activities related to GLOBE have you participated in since 2002? (Mark [X] all that apply.)

- ☐ a. Participation in an in-district workshop or institute
- ☐ b. Attendance at a college course
- ☐ c. Attendance at an out-of-district workshop or institute
- ☐ d. Participation in a teacher collaborative or network
- ☐ e. Attendance at an out-of-district conference
- ☐ f. Working in an internship or immersion activity
- ☐ g. Working with a mentor, coach, lead teacher, or observer
- ☐ h. Use of a teacher resource center
- ☐ i. Participation in a teacher committee or task force
- ☐ j. Participation in a teacher study group
- ☐ k. Other (please specify): ______
- ☐ l. Other (please specify): ______

IMPORTANT: Please read carefully!

4. If you DID NOT mark any boxes in question 3 above, you should answer the questions in Parts II and III of the survey with your initial protocol training in mind. Please mark [X] the box below and skip question 5.

- ☐ Initial protocol training

If you DID mark any of the professional development experiences listed in question 3 above, we want to know more about the professional development experience that you have completed or been engaged in MOST RECENTLY. Please mark that professional development experience in question 5 in Part I. Please answer the questions in Parts II and III of the survey with that experience in mind.

For example, if you have been receiving mentoring from a GLOBE partner, we want you to answer Parts II and III of this survey with respect to the mentoring visits.

5. Which professional development experience have you selected? (Mark [X] only ONE box.)

- ☐ a. Participation in an in-district workshop or institute
- ☐ b. Attendance at a college course
- ☐ c. Attendance at an out-of-district workshop or institute
- ☐ d. Participation in a teacher collaborative or network
- ☐ e. Attendance at an out-of-district conference
- ☐ f. Working in an internship or immersion activity
- ☐ g. Working with a mentor, coach, lead teacher, or observer
- ☐ h. Use of a teacher resource center
- ☐ i. Participation in a teacher committee or task force
- ☐ j. Participation in a teacher study group
- ☐ k. Other (description you wrote in for letter "k" in question 3)
- ☐ l. Other (description you wrote in for letter "l" in question 3)

Part II:
Focus on a Single GLOBE Professional Development Experience: Structure and Content of the Experience

In this (and the next) section of this survey, please answer all questions with respect ONLY to the professional development experience you identified in question 5. If you skipped question 5, answer the questions about your initial protocol training. (We are trying to learn about *particular* GLOBE professional development experiences, not all of the professional development combined.)

NOTE that this section of the survey is designed to *describe* the structure and content of the professional development experience, *not* its impact on you or your students.

1. Which of the following describes the participants in this professional development? (Mark [X] all that apply.)

- ☐ a. Teachers as individuals
- ☐ b. Teachers as representatives of their departments, grade levels, or schools
- ☐ c. All teachers in department or grade-level groupings
- ☐ d. All teachers in a school or set of schools
- ☐ e. Other configuration (please specify):

2. Between May 2002 and April 2005, including the main professional development you identified and any preliminary activities or formal follow-up sessions, how many hours were you engaged in this activity overall? (Please enter whole numbers.)

☐☐☐ hours

3. How many additional hours do you expect to be engaged in this professional development during the remainder of the current school year? (Please enter whole numbers.)

☐☐☐ hours

4. Over what period of time did the professional development occur, including the main experience and any formal preliminary or follow-up sessions? (Mark [X] one box.)

- ☐ a. Less than one day
- ☐ b. One day
- ☐ c. Two to four days
- ☐ d. One week
- ☐ e. One month
- ☐ f. More than one month

5. In what month or months did the professional development (including any preliminary activities or formal follow-up sessions) take place? (Mark [X] the appropriate month(s) on the timeline below.)

May 2002	Jun 2002	Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002	Jan 2003	Feb 2003	Mar 2003	Apr 2003
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
May 2003	Jun 2003	Jul 2003	Aug 2003	Sep 2003	Oct 2003	Nov 2003	Dec 2003	Jan 2004	Feb 2004	Mar 2004	Apr 2004
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
May 2004	Jun 2004	Jul 2004	Aug 2004	Sep 2004	Oct 2004	Nov 2004	Dec 2004	Jan 2005	Feb 2005	Mar 2005	Apr 2005
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. How much time was given to each of the following as part of this professional development? (NOTE: "protocols" refer to the scientific data gathering, while "learning activities" refer to materials designed to help your students learn about the associated science.) (Mark [X] one box for each line.)

	None	Hardly any (up to 1 hour)	Some (1.1-2 hours)	A significant amount (2.1-3 hours)	A great deal (more than 3 hours)
a. Atmosphere protocols	☐	☐	☐	☐	☐
b. Atmosphere learning activities	☐	☐	☐	☐	☐
c. Hydrology protocols	☐	☐	☐	☐	☐
d. Hydrology learning activities	☐	☐	☐	☐	☐
e. Land Cover/Biology protocols	☐	☐	☐	☐	☐
f. Land Cover/Biology learning activities	☐	☐	☐	☐	☐
g. Soil protocols	☐	☐	☐	☐	☐
h. Soil learning activities	☐	☐	☐	☐	☐
i. Earth as a System protocols	☐	☐	☐	☐	☐
j. Earth as a System learning activities	☐	☐	☐	☐	☐
k. GPS	☐	☐	☐	☐	☐
l. Hands-on practice using GLOBE data reporting forms & Web site	☐	☐	☐	☐	☐
m. Hands-on practice using GLOBE data visualizations	☐	☐	☐	☐	☐
n. Use of inquiry with GLOBE data	☐	☐	☐	☐	☐
o. Ways to integrate inquiry into the classroom	☐	☐	☐	☐	☐
p. Ways to integrate GLOBE with state/regional/national standards	☐	☐	☐	☐	☐
q. Ways to integrate GLOBE with curricula	☐	☐	☐	☐	☐
r. Classroom implementation planning	☐	☐	☐	☐	☐
s. Mentoring/feedback on classroom implementation steps taken between training sessions	☐	☐	☐	☐	☐
t. Other (please specify):	☐	☐	☐	☐	☐

53973

7. To what extent was the professional development you identified characterized by the following? (Mark [X] one box for each line.)

	Not at all	A little	Somewhat	A lot	To a great extent	Not applicable
a. Consistent with your own goals for your professional development	☐	☐	☐	☐	☐	☐
b. Consistent with existing reform ideas within your school or department related to teaching practice	☐	☐	☐	☐	☐	☐
c. Based explicitly on what you had learned in earlier professional development experiences	☐	☐	☐	☐	☐	☐
d. Followed up with activities in professional development that built on what you learned in this professional development activity	☐	☐	☐	☐	☐	☐
e. Designed to support state or district standards/curriculum frameworks	☐	☐	☐	☐	☐	☐
f. Designed to support state or district assessment	☐	☐	☐	☐	☐	☐

8a. As part of the professional development activity you selected, including any preliminary activities or follow-up sessions, did you get feedback or guidance as part of or related to the professional development?

☐ Yes

☐ No ***If "No," please skip question 8b and go to question 9.***

8b. What kinds of feedback or guidance did you receive as part of or related to the professional development? (Mark [X] all that apply.)

☐ a. Practiced under simulated conditions, with feedback.

☐ b. Received coaching or mentoring in the classroom.

☐ c. Met formally with other activity participants to discuss classroom implementation.

☐ d. My teaching was observed by the activity leader(s), and feedback was provided.

☐ e. My teaching was observed by other participants, and feedback was provided.

☐ f. Communicated with the leader(s) of the activity concerning classroom implementation.

☐ g. My students' work was reviewed by participants or the activity leader.

☐ h. Met informally with other participants to discuss classroom implementation.

☐ i. Developed curricula or lesson plans, which other participants or the activity leader reviewed.

☐ j. Other (please specify): ______________________

9. Which of the following did YOU engage in or do during the professional development? (Mark [X] all that apply.)

- ☐ a. Gave a lecture or presentation
- ☐ b. Conducted a demonstration of a lesson, unit, or skill
- ☐ c. Led a whole-group discussion
- ☐ d. Led a small-group discussion
- ☐ e. Wrote a paper, report, or plan
- ☐ f. Practiced using student materials
- ☐ g. Reviewed student work
- ☐ h. Scored assessments

10. How much EMPHASIS did the designers or leaders of the professional development give to each of the following areas? NOTE: This question is about the design of the professional development. Later in the survey, we will ask you a similar question about the impact of the professional development on you and your teaching. (Mark [X] one box for each line.)

	None at all	A little	Some	A lot	A great deal
a. Deepening participants' knowledge of science	☐	☐	☐	☐	☐
b. Having students memorize basic facts and formulas that are emphasized in the textbook	☐	☐	☐	☐	☐
c. Doing hands-on/laboratory activities	☐	☐	☐	☐	☐
d. Working on projects that take a week or more	☐	☐	☐	☐	☐
e. Suggesting or helping plan classroom investigations	☐	☐	☐	☐	☐
f. Collecting environmental data in the field	☐	☐	☐	☐	☐
g. Interpreting multiple representations of the same data (e.g., table and graph)	☐	☐	☐	☐	☐
h. Identifying possible causes of variation in data (e.g., measurement error)	☐	☐	☐	☐	☐
i. Analyzing data from multiple sources about a single phenomenon	☐	☐	☐	☐	☐
j. Generating explanations of data related to complex phenomena	☐	☐	☐	☐	☐
k. Writing a report in which students are expected to explain their thinking or reasoning at some length	☐	☐	☐	☐	☐
l. Formulating scientific questions	☐	☐	☐	☐	☐
m. Making predictions about data students are collecting	☐	☐	☐	☐	☐
n. Developing presentations of student findings	☐	☐	☐	☐	☐

11. Have you discussed or shared what you learned with other teachers in your school or department *who did not* attend the professional development?

☐ Yes ☐ No

12. Have you discussed or shared what you learned with your administrators (e.g., principal or department chair)?

☐ Yes ☐ No

13. Outside of formal meetings held as part of the professional development, have you communicated with teachers who participated in the activity who teach in other schools?

☐ Yes ☐ No

14. How was the professional development evaluated (if evaluated)? (Mark [X] all that apply.)

☐ a. Participants completed a survey.

☐ b. Participants were interviewed to provide feedback.

☐ c. The session was observed by an evaluator.

☐ d. My classroom was observed.

☐ e. Student outcomes in my classroom were evaluated.

☐ f. Some other form of evaluation took place (please specify):

☐ g. No discernible evaluation took place.

Part III:
Focus on a Single GLOBE Professional Development Experience: Outcomes of the Experience

In this (as in the preceding) section of this survey, please answer all questions with respect ONLY to the professional development experience you identified in question 5 of Part I of the survey. If you skipped question 5, answer the questions about your initial protocol training. (We are trying to learn about *particular* GLOBE professional development experiences, not all of the professional development combined.)

NOTE that this section of the survey is focused on the *impact* of the professional development on *you* and *your students.*

1. To what extent do you feel that your knowledge and skills have been enhanced in each of the following areas as a result of your participation in the identified professional development? (Mark [X] one box for each line.)

	Not at all	A little	Some	A lot	A great extent
a. Curriculum (e.g., units, texts, standards)	☐	☐	☐	☐	☐
b. Instructional methods	☐	☐	☐	☐	☐
c. Approaches to assessment	☐	☐	☐	☐	☐
d. Use of technology in instruction (e.g., computers, graphing calculators)	☐	☐	☐	☐	☐
e. Strategies for teaching diverse student populations (e.g., students with disabilities, from underrepresented populations, economically disadvantaged, range of abilities)	☐	☐	☐	☐	☐
f. Deepening knowledge of science	☐	☐	☐	☐	☐

2. Think about the GLOBE professional development experience you have selected to focus on and mark [X] the box that best shows how much you agree or disagree with each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. The professional development prepared me to implement GLOBE protocols with my students.	☐	☐	☐	☐	☐
b. The professional development prepared me to implement GLOBE learning activities with my students.	☐	☐	☐	☐	☐
c. The professional development prepared me to adapt GLOBE to the ability levels and learning styles of my students.	☐	☐	☐	☐	☐
d. The professional development prepared me to adapt GLOBE to state/local science standards.	☐	☐	☐	☐	☐

3. To what extent did the professional development increase your knowledge and/or confidence in each of the following areas? NOTE: This question is similar to question 10 in Part II, but this time we want you to focus on the impact of the professional development.
(Mark [X] one box for each line.)

	None at all	A little	Some	A lot	A great deal
a. Deepening your knowledge of science	☐	☐	☐	☐	☐
b. Having students memorize basic facts and formulas that are emphasized in the textbook	☐	☐	☐	☐	☐
c. Doing hands-on/laboratory activities	☐	☐	☐	☐	☐
d. Working on projects that take a week or more	☐	☐	☐	☐	☐
e. Suggesting or helping plan classroom investigations	☐	☐	☐	☐	☐
f. Collecting environmental data in the field	☐	☐	☐	☐	☐
g. Interpreting multiple representations of the same data (e.g., table and graph)	☐	☐	☐	☐	☐
h. Identifying possible causes of variation in data (e.g., measurement error)	☐	☐	☐	☐	☐
i. Analyzing data from multiple sources about a single phenomenon	☐	☐	☐	☐	☐
j. Generating explanations of data related to complex phenomena	☐	☐	☐	☐	☐
k. Writing a report in which students are expected to explain their thinking or reasoning at some length	☐	☐	☐	☐	☐
l. Formulating scientific questions	☐	☐	☐	☐	☐
m. Making predictions about data students are collecting	☐	☐	☐	☐	☐
n. Developing presentations of student findings	☐	☐	☐	☐	☐

4a. Have you attempted to make changes in your teaching because of your participation in the identified professional development?

☐ Yes

☐ No ***If "No," please skip to question 6.***

4b. If you answered "Yes" on question 4a, to what extent have you made changes in each of the following aspects of your teaching as a result of the professional development? (Mark [X] one box for each line.)

	No change	Minor change	Moderate change	Significant change
a. The science curriculum content	☐	☐	☐	☐
b. The cognitive challenge of science classroom activities	☐	☐	☐	☐
c. The instructional methods I employ	☐	☐	☐	☐
d. The types or mix of assessments I use to evaluate students' work	☐	☐	☐	☐
e. The ways I use technology in instruction (e.g., calculator or computer)	☐	☐	☐	☐
f. The approaches I take to meet the needs of diverse students	☐	☐	☐	☐

5. If you answered "Yes" on question 4a, to what extent have you made each of the following changes in your teaching practices as a result of the GLOBE professional development you identified? (Mark [X] one box for each practice.)

	None at all	A little bit	Somewhat	A lot	A great deal
a. I have used some GLOBE-related explanations and examples in my teaching.	☐	☐	☐	☐	☐
b. I have used GLOBE materials to teach topics I was teaching before with other materials.	☐	☐	☐	☐	☐
c. I have introduced new topics based on GLOBE into my curriculum.	☐	☐	☐	☐	☐
d. I have incorporated more hands-on science activities.	☐	☐	☐	☐	☐
e. I have given more emphasis to observation and measurement.	☐	☐	☐	☐	☐
f. I have given more emphasis to data analysis.	☐	☐	☐	☐	☐
g. I have had students design and conduct science investigations.	☐	☐	☐	☐	☐
h. I have had students use Web-based science resources (not including GLOBE data entry).	☐	☐	☐	☐	☐
i. Other (please describe):	☐	☐	☐	☐	☐

6. How much has your selected professional development experience helped your students to achieve the following objectives? (Mark [X] one box for each objective.)

	Not at all	Not very much	Some-what	Very much	Don't know
a. Improve science achievement	☐	☐	☐	☐	☐
b. Increase the likelihood of pursuing a career in science	☐	☐	☐	☐	☐
c. Increase awareness of the global environment	☐	☐	☐	☐	☐
d. Understand the nature of scientific research	☐	☐	☐	☐	☐
e. Contribute data for scientists to use in their research	☐	☐	☐	☐	☐
f. Achieve state and local education goals and standards	☐	☐	☐	☐	☐
g. Other (please specify):	☐	☐	☐	☐	☐

Part IV: General Information about GLOBE Implementation

This section is about GLOBE participation in general and is no longer focused on professional development.

1. In school year 2005-05, which, if any, of the following GLOBE protocols did you implement in your classes? (Mark [X] one box for each protocol area.)

	Did not implement	Have not yet implemented but plan to	Implemented
a. Atmosphere/Climate protocols	☐	☐	☐
b. Hydrology protocols	☐	☐	☐
c. Land Cover/Biology protocols	☐	☐	☐
d. Soil protocols	☐	☐	☐
e. GPS protocol	☐	☐	☐
f. Phenology (Earth as a System) protocols	☐	☐	☐

2. What kinds of support has a GLOBE partner provided you since your initial protocol training? (Mark [X] all that apply.)

- ☐ a. Received GLOBE equipment
- ☐ b. Assistance on technical setup and equipment use
- ☐ c. Incentives in return for reporting certain types or amounts of data
- ☐ d. Monitoring and feedback on data reporting contributions
- ☐ e. Supplemental materials (e.g., implementation tips, additional learning activities)
- ☐ f. Alignment of GLOBE activities with state or local curriculum or accountability requirements
- ☐ g. Site visits by partnership staff or mentor teachers
- ☐ h. Personal contact with partnership staff or mentor teachers through phone or e-mail
- ☐ i. Contacts with scientists

2b. What additional support (either from a partner or from GLOBE) would facilitate your work in GLOBE?

3. How important was each of the following potential barriers in keeping you from implementing GLOBE with your students? (Mark [X] one box for each barrier.)

	Not a barrier	Minor barrier	Major barrier
a. Difficulty finding time to prepare for implementing GLOBE.	☐	☐	☐
b. Lack of technology access.	☐	☐	☐
c. Lack of technical support for using computers and software.	☐	☐	☐
d. GLOBE does not align well with curriculum standards I am required to teach.	☐	☐	☐
e. GLOBE does not prepare students adequately for standardized tests in science.	☐	☐	☐
f. Difficulty identifying an appropriate site for taking GLOBE measurements.	☐	☐	☐
g. Difficulty completing GLOBE activities within the school schedule.	☐	☐	☐
h. Lack of a good way to collect GLOBE data on weekends, vacations, etc.	☐	☐	☐
i. Change in teaching assignment.	☐	☐	☐
j. Unsupportive administrators.	☐	☐	☐

Part V: Your School Context and Professional Background

1. Which category best describes your school? (If your school covers several of these categories, select the level at which students are most active in GLOBE.) (Mark [X] one box.)

☐ Elementary (Grades K-5, ages 5-10)
☐ Middle school or junior high (Grades 6-8, ages 11-13)
☐ High school (Grades 9-12, ages 14 and up)

2. Which grade(s) do you teach GLOBE in? (Mark [X] all that apply.)

☐ K ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12

3. Including yourself, how many GLOBE-trained teachers were at your school in 2004-05?

Number of GLOBE teachers: ☐☐☐

4. How many students participate in GLOBE in your school each year, on average? ☐☐☐☐

5. What is your gender?

☐ Female
☐ Male

6. Please indicate your ethnicity/race. (Mark [X] one box.)

☐ American Indian or Alaska Native
☐ Asian or Pacific Islander
☐ African-American, not of Hispanic origin
☐ White, not of Hispanic origin
☐ Hispanic
☐ Other (please specify): ____________________

7. How many years of teaching experience do you have?

Overall: ☐☐ years

Teaching science: ☐☐ years

8. Please mark the box(es) next to the degree(s) you hold. Use the list of code numbers from below to indicate your major and minor fields of study for each degree.

Post secondary degrees	Yes	No	Major field (Enter field code from list below)	Second major/minor (Enter field code from list below)	Enter year of degree
a. Bachelor's degree	☐	☐			
b. 2nd Bachelor's degree	☐	☐			
c. Master's degree	☐	☐			
d. 2nd Master's degree	☐	☐			
e. Doctorate (e.g., Ph.D., Ed.D.)	☐	☐			
f. Professional degree (e.g., M.D., L.L.B., J.D., D.D.S.)	☐	☐			

List of Teaching Field and College Major Codes for question 8:

Education

01	Elementary education
02	Middle school education
03	Secondary education
04	Mathematics education
05	Science education
06	Special education
07	Bilingual education
08	Other general education

Science

11	Biology/life science
12	Geology/earth sciences
13	Chemistry
14	Physics
15	Engineering
16	Other natural sciences

Math/Computer Science

21	Mathematics
22	Computer science

Other

31	English/language arts
32	Social sciences/social studies
33	Vocational ed./agriculture
34	Arts/music
35	Foreign languages
36	Philosophy
37	Psychology
38	Health/PE
40	Other (specify):
50	Administration

9. In the list of fields and college majors below, please mark [X] the box next to each area in which you have certification.

Education

- ☐ **01** Elementary education
- ☐ **02** Middle school education
- ☐ **03** Secondary education
- ☐ **04** Mathematics education
- ☐ **05** Science education
- ☐ **06** Special education
- ☐ **07** Bilingual education
- ☐ **08** Other general education

Science

- ☐ **11** Biology/life science
- ☐ **12** Geology/earth sciences
- ☐ **13** Chemistry
- ☐ **14** Physics
- ☐ **15** Engineering
- ☐ **16** Other natural sciences

Math/Computer Science

- ☐ **21** Mathematics
- ☐ **22** Computer science

Other

- ☐ **31** English/language arts
- ☐ **32** Social sciences/social studies
- ☐ **33** Vocational ed./agriculture
- ☐ **34** Arts/music
- ☐ **35** Foreign languages
- ☐ **36** Philosophy
- ☐ **37** Psychology
- ☐ **38** Health/PE
- ☐ **40** Other (specify): ____________
- ☐ **50** Administration

Thank you very much for your help in completing this survey. Please use the enclosed business reply envelope to return the survey to the address below:

GLOBE Evaluation
SRI International
Room BS 134
333 Ravenswood Avenue
Menlo Park, CA
94025

Hypotheses Guiding GLOBE ONE Case Studies

The following are the specific hypotheses guiding our research; they are grouped into sets, and each set includes alternate conjectures about potential outcomes and explanations for outcomes.

H_1: GLOBE ONE scientists' visits and presence function to motivate the participation of schools in the project and enables accurate data collection.
H_{1alt}: Low level of participation from schools prevents the collection of data adequate for scientists' needs.

H_2: Achieving the goal of writing 10 articles will require GLOBE ONE scientists to adjust their own inquiry process.
H_{2alt}: Achieving the goal of writing 10 articles will be impossible because of the compressed timeline and limitations in student-collected data.

H_3: GLOBE ONE will result in a sustained higher level of data reporting among participating schools.
H_{3alt}: GLOBE ONE will result in a short jump in data reporting but drop off after the end of the project.
H_{3alt}: There will be no change in data reporting levels, since GLOBE ONE was implemented among currently active GLOBE schools.

H_4: Community groups and scientists augment the support available for data reporting.
H_{4rival}: Community groups and scientists add data reporting capacity to the region overall, but not to schools.

H_5: Community groups and scientists give students the opportunity to collect soils and land cover data (less commonly implemented protocols in GLOBE) they would not otherwise have had the opportunity to collect.
H_{5alt}: Students do not actually collect soils and land cover data, at least not at rates different from before GLOBE ONE began.

GLOBE ONE Scientist Interview PRE

INTRODUCTION

Thank you for taking the time to talk to me today. The purpose of this interview is to document experiences with GLOBE ONE as part of a case study of GLOBE ONE for the GLOBE program evaluation. Ideally we would like to learn enough about GLOBE ONE in order to make it possible to implement such a project again taking into account what was learned in this first effort. I will also contact you regarding an interview towards the end of GLOBE ONE. If it's okay with you, I will be audio recording this interview in order to ensure accuracy.

BACKGROUND

1. Could you please tell me about your background and current job? [*Education/training, research area and organizational affiliation.*]

2. When and how did you get involved with GLOBE? [*When joined/trained; role[s); activities; benefits to participation.*]

3. How did you learn about GLOBE ONE? [*Capture story about getting involved and overview of current structure and plans for participation.*]

4. What motivated you to participate in GLOBE ONE? What benefits to participation did you see for scientists, students, community groups? For yourself? [*Listen for expectations about interaction with/impact on students.*]

GLOBE ONE RESEARCH

5. How does work on GLOBE ONE fit in with your own research goals?

6. What is your role in GLOBE ONE? [*Probe for specific responsibilities and activities, generally and in relation to students.*]

7. How did you go about choosing the research question for your investigation area? [*Probe for geography, availability of data collection sites.*]

8. What is the significance of this question for the field? (Or, why focus on this question?)

9. How often do data need to be collected to answer this question? By whom will they be collected as part of GLOBE ONE?

10. [*If not just schools is the answer:*] Would it be possible for schools to collect all the data you need? Why or why not?

11. What support do you expect to have to provide to those collecting data?

12. How will data collection be monitored for your protocol?

13. How will the results from the study be used by scientists? By schools? By the community?

SCHOOL PARTICIPATION

14. Have you been in touch with any schools that are part of GLOBE ONE?

15. [*If yes:*] What was the nature of your work together?

16. From your point of view, what is the level of commitment of schools to the project that are involved so far?

PERSPECTIVES ON SUCCESS

17. Who or what has kept the project moving forward?

18. What are the chief obstacles to success?

19. What's your view of the likely accomplishments of GLOBE ONE?

20. What do you worry won't be accomplished?

21. Is there anything that I have not asked you about that you would like to add?

GLOBE ONE Scientist Interview POST

INTRODUCTION

Thank you for taking the time to talk to me today. The purpose of this interview is to document experiences with GLOBE ONE as part of a case study of GLOBE ONE for the GLOBE program evaluation. Ideally we would like to learn enough about GLOBE ONE in order to make it possible to implement such a project again taking into account what was learned in this first effort. If it's okay with you, I will be audio recording this interview in order to ensure accuracy.

KEY GLOBE ONE ACTIVITIES

1. What have been the most significant moments in the evolution of GLOBE ONE in the past year?

2. What made these events/moments significant, from your point of view?

3. How have you been involved in GLOBE ONE since we last talked? [*Probe for trips to Iowa, research activities, seeking external funding for activities*]

GLOBE ONE RESEARCH

4. *If scientists relied on student-collected data,* Overall, how consistent and accurate were the data reported by schools in GLOBE ONE? *If not very consistent,* what got in the way of consistent data reporting? *If not very accurate,* What made it difficult for students to report accurate data?

5. What support, if any, did you provide to schools directly or to Iowa partner staff to facilitate data collection and reporting?

6. What kinds of data that have been collected have turned out to be useful to answering the research questions you had posed initially? *If not very useful,* Is there another problem or question that the data can address instead?

7. After this spring, what will happen with the data collected as part of your own research?

8. Where do you anticipate trying to publish or present your findings? *If a journal is mentioned:* How long do you think it will take before there is a manuscript ready for submission to a peer-reviewed journal?

9. How will data collection be monitored for your protocol?

10. How will the results from the study be used by scientists? By schools? By the community?

SCHOOL PARTICIPATION

11. Have you been in touch with any schools that are part of GLOBE ONE at any time during this school year?

12. [*If yes:*] What was the nature of your work together?

13. Do you anticipate any further contact with the students and teachers in Iowa that have been part of GLOBE ONE this year?

14. Have you observed students participating in any new activities in their science classrooms (or beyond the classroom) as part of their participation in GLOBE ONE? Any activities they would not have otherwise?

15. As part of GLOBE ONE, have you observed the students/scientists adapting their activities to accommodate one another? Examples?

PERSPECTIVES ON SUCCESS

16. What has worked well/not so well in having students work with scientists?

17. What's your view of the accomplishments of GLOBE ONE so far? Ultimately?

18. What hasn't been accomplished that was part of the original goals?

19. What kind of effect, if any, has GLOBE ONE had on students' understanding of science?

20. What kind of effect, if any, has GLOBE ONE had as a result of students working with scientists?

21. From your point of view, what (if any) is the benefit of working with schools on a project like GLOBE ONE?

22. Is there anything that I have not asked you about that you would like to add?

GLOBE ONE
Teacher Pre-Interview Protocol

Thank you so much for taking the time to talk with me today. The purpose of this interview is to document experiences with GLOBE ONE as part of a case study of GLOBE ONE for the GLOBE program evaluation. The goal of this project is to learn enough about GLOBE ONE in order to make it possible to implement such a project again, taking into account what was learned in this first effort. I'll also be contacting you regarding an interview towards the end of GLOBE ONE. If it's okay with you, I'll be audio recording this interview in order to ensure accuracy. Is that ok?

BACKGROUND

1. Can you please begin by telling me about your current job/background?
   Probe for the following:
   a. What subject and grade do you teach?
   b. What is the general background of your students?
   c. How many years have you been teaching science?
   d. How many years have you been teaching at this school?

2. When and how did you learn about and get involved with the GLOBE project?
   a. What year did you get trained and start working with GLOBE?
   b. How active have you been with the Program over the years?

3. When and how did you learn about and get involved with GLOBE ONE?
   Then probe for answers to the following and capture story of getting involved with the Program:
   a. When did you join GLOBE ONE?
   b. What motivated you to get involved with?
   c. When and how were you trained for GLOBE ONE?
   d. What are your roles/activities in GLOBE ONE?
   e. What are your plans for participation in GLOBE ONE?
   f. What do you hope to get out of your participation in the project?

4. How does GLOBE ONE fit in with your teaching?
    a. What have you had to change in your teaching in order to accommodate GLOBE ONE?
    b. How does GLOBE ONE align with your goals for student learning?
    c. How does the program fit in with your county's or district standards?
    d. What about with the ITBS (Iowa Test of Basic Skills)? [*Probe for disconnect with standards-driven teaching.]*

WORKING WITH SCIENTISTS

5. Are you working with any GLOBE ONE scientists?

6. What is the nature of your work together?

7. What support did you get specifically from *GLOBE* scientists in implementing the *GLOBE* ***ONE*** program in your classroom?

8. In your view, how have scientists adapted to working with students? How do students feel about working with scientists? *[Probe for successes/challenges]*

9. What are the science reasons behind the data you and your students are collecting? Do you know what scientists are trying to find out? Do your students know what scientists are trying to find out?

10. How much would you say your students know about the science of their local ecosystems (including prairie and farmland)? Have they learned more from GLOBE ONE?

COMMUNITY SUPPORT

11. What roles have Marcy and Kurt played in helping you?

12. What support did you get specifically from community groups in implementing the GLOBE ONE program in your classroom?

13. Have you worked with science-oriented community groups or local scientists outside of GLOBE prior to GLOBE ONE? *[Nb: Let's not forget to ask about local scientists too, not just GLOBE ones]*.

14. Would you have been able to implement this protocol without the support of the GLOBE ONE community?

15. What's something you'll remember about GLOBE ONE? Can you walk me through a memorable experience?

PERSPECTIVES ON SUCCESS

16. Who or what has kept the project moving forward?

17. What level of commitment do you think schools have to the project?

18. What are the chief obstacles to success with respect to your educational goals for the program?

19. Do you think you will continue to collect data after GLOBE ONE is over? Why or why not?

20. What parts of the GLOBE ONE project have worked well with students?

21. Do you think there will be a lasting impact of GLOBE ONE for students? How about for the community? Will there be a lasting impact for you?

22. What's your view of the likely accomplishments of GLOBE ONE?

23. What do you worry won't be accomplished?

24. Is there anything that I haven't asked you about that you'd like to add regarding your experience with the GLOBE ONE project?

…More questions on GLOBE follow—to ask if there is time remaining at the end of the interview...

SPECIFIC BACKGROUND WITH GLOBE

[Both prior to GLOBE ONE and as part of GLOBE ONE]

25. When and how did you get involved with GLOBE?
    a. When did you join GLOBE?
    b. When/Where were you trained?
    c. What have your roles and activities been in the Program?
    d. What are some benefits to participation for you?

26. In the past, what protocols have you been trained in?

27. What protocols have you implemented in your classroom?

28. What learning activities have you used with students?

29. What other GLOBE-related activities have you conducted with students in the past?

30. How do you assess your students on their GLOBE-related activities?

GLOBE ONE
Teacher Post-Interview Protocol

Thank you so much for taking the time to talk with me today. This is a follow-up to the interview we did back in the fall. The purpose of the interviews is to document experiences with GLOBE ONE as part of a case study of GLOBE ONE for the GLOBE program evaluation. At this point in the year, we are interested in hearing your perspective of how GLOBE ONE has worked over the course of the year as a whole. The goal of this project is to learn enough about GLOBE ONE in order to make it possible to implement such a project again, taking into account what was learned in this first effort. If it's okay with you, I'll be audio recording this interview in order to ensure accuracy. Is that ok?

BACKGROUND

1. What have you been doing in GLOBE ONE since we last talked/since I saw your students in March?

REFLECTION ON GLOBE ONE EXPERIENCE

2. In your view, how is GLOBE ONE different from GLOBE?

3. After doing GLOBE ONE for a year, how would you say your participation in GLOBE ONE has been different from your participation in GLOBE in previous years? (more data collection? More students? Looked at more data?)

4. What have your roles/activities in GLOBE ONE been since we last talked?

    a. Which protocols are your students doing?

    b. Have your students gone on any field trips related to GLOBE ONE (e.g. muc-a-thons)? Please describe when, activity done, and who was there.

5. What parts of the GLOBE ONE project have worked well with students?

6. Where in the school do you go to report data? If not in the classroom, are there any difficulties with access?

7. How accurate do you think your students' data are?

8. Have you had to adapt any of the protocols so your students can do them? What about for different kinds of students (e.g., different achievement levels, special education)?

WORKSHOPS AND TRAINING

9. Have you had additional trainings or workshops for GLOBE ONE over the course of this year? What did you learn about/do in the trainings?

    a. Did you attend the March Inquiry workshop?

        i. Have you implemented anything in your classroom based on what you learned in the workshop? Please describe.

        ii. Looking back, what was the most useful and relevant part of that workshop?

        iii. What has proven to be less useful for your classroom?

10. Have you looked at data with your students this year? Had you done it before? (a result of GLOBE ONE participation)?

    a. Which data? Did you look at automated data?

    b. What made it possible to look at data?

    c. What was the context for the activity? How did you introduce it? Where did it fit in the curriculum? Please describe (including what the project was).

11. How has GLOBE ONE fit in with your teaching since we last talked?

   a. What have you had to change in your teaching in order to accommodate GLOBE ONE?
   b. How does GLOBE ONE align with your goals for student learning?
   c. Any changes in how the program fits in with your county's or district standards?
   d. What about with the ITBS (Iowa Test of Basic Skills)?

12. What have been the chief successes and main challenges to implementing GLOBE ONE in your classroom?

    a. Did you have the capacity to implement the project? If NO, what was lacking?

    b. What capacity do schools need to be able to implement a project like GLOBE ONE?

    c. Is this different from implementing GLOBE alone?

WORKING WITH SCIENTISTS

13. Have you worked with any GLOBE ONE scientists since we last talked?

14. What has the nature of your work together been?

15. What impact did visits from scientists have in your classroom?

16. In your view, how have scientists adapted to working with students? How do students feel about working with scientists? *[Probe for successes/challenges]*

17. What are the science reasons behind the data you and your students are collecting for GLOBE ONE? Do you know what scientists are trying to find out? Do your students know what scientists are trying to find out?

18. How much would you say your students know about the science of their local ecosystems (including prairie and farmland)? Have they learned more from GLOBE ONE?

COMMUNITY SUPPORT

19. What roles have Marcy and Amber played in helping you since we last talked?

20. What support have you gotten specifically from community groups in implementing the GLOBE ONE program in your classroom since we last talked (e.g. donations, volunteers…)?

21. In your view, has GLOBE ONE's involvement in schools and the community changed the community perception of GLOBE in any way?

22. Would you have been able to implement this protocol without the support of the GLOBE ONE community?

PERSPECTIVES ON SUCCESS

23. Have your students surprised you in any way during this year of working in GLOBE ONE? Did you see any changes in student data reporting, projects etc. relative to what you've done in GLOBE in other years?

24. At this point in the year, who or what would you say has kept the project moving forward over the course of this school year?

25. What are your plans for GLOBE/GLOBE ONE participation next year? Do you think you will continue to collect data after GLOBE ONE is over? Why or why not?

26. Do you think there will be a lasting impact of GLOBE ONE for students? How about for the community? Will there be a lasting impact for you?

27. What's something you'll remember about GLOBE ONE? Can you walk me through a memorable experience?

28. Is there anything that I haven't asked you about that you'd like to add regarding your experience with the GLOBE ONE project?

GLOBE ONE Community Interview

INTRODUCTION

Thank you for taking the time to talk to me today. The purpose of this interview is to document experiences with GLOBE ONE as part of a case study of GLOBE ONE for the GLOBE program evaluation. Ideally we would like to learn enough about GLOBE ONE in order to make it possible to implement such a project again taking into account what was learned in this first effort. I will also contact you regarding an interview towards the end of GLOBE ONE. If it's okay with you, I will be audio recording this interview in order to ensure accuracy.

BACKGROUND

1. Could you please tell me about your background in relation to GLOBE ONE? [Possibly education/training, research experiences, and organizational affiliations.]

2. When and how did you get involved with GLOBE? [When joined/trained; role[s); activities; benefits to participation.]

3. How did you learn about GLOBE ONE? [Capture story about getting involved and overview of current structure and plans for participation.]

4. Who do you interact with regarding GLOBE ONE?

5. What motivated you to participate in GLOBE ONE? What benefits to participation did you see for scientists, students, community groups? For yourself? [*Listen for expectations about interaction with/impact on students.*]

6. How will the results from the study be used by scientists? By schools? By the community?

SCHOOL PARTICIPATION

7. Have you been in touch with any schools that are part of GLOBE ONE?

8. [*If yes:*] What was the nature of your work together?

PERSPECTIVES ON SUCCESS

9. How does work on GLOBE ONE fit in with your own organization’s goals?

10. What are the chief obstacles to a successful GLOBE ONE experience?

11. What’s your view of the likely accomplishments of GLOBE ONE?

12. What do you worry won’t be accomplished?

13. Is there anything that I have not asked you about that you would like to add?

POST INTERVIEW

Note that these questions can be asked in the preinterview if time allows, adapting questions to a looking forward perspective.

14. What have been the most significant moments in the evolution of GLOBE ONE in the past year?

15. What made these events/moments significant, from your point of view?

16. Will you continue doing this data collection now that GLOBE ONE has finished?

17. From your point of view, what (if any) is the benefit of working with schools on a project like GLOBE ONE?

Ask some or all of the following selected if you know that the community member has had sufficient involvement with schools to answer them.

18. Have there been any surprises in the kinds of responses schools have had to the project?

19. What has worked well/not so well in having students work with scientists?

20. Have the students/scientists adapted their activities to accommodate one another? Examples?

21. Are students participating in any new activities? Any they would not have otherwise?

22. Will these activities continue after GLOBE ONE?

23. What kind of effect, if any, has GLOBE ONE had on students' understanding of science?

24. What kind of effect, if any, has GLOBE ONE had as a result of students working with scientists?

Student Interview Protocol

Additional student questions:
- Focus groups, 20-25 mins.
- Individual students, 10-15 mins

What did you learn about how science works?

Describe for me one of your experiences in GLOBE ONE. Tell me in detail what you did.

- What grade are you in? (S)
- What do you like most about your school? (S)
- What do you like least about your school? (S)
- Is there anything that surprised you that you learned about scientists? (T, S)
- What do you do for data collection and reporting? (S)
- Can you walk me through an experience you had with GLOBE ONE? (S)
- Why are you collecting the data that you are collecting? (S)
- What do you like about GLOBE? (S)

1. Where in the school do you go to report data? If not in the classroom, are there any difficulties with access? (T)

2. How accurate do you think your students' data are? (T)

3. What do you do for data collection and reporting? (S)

3.5. Can you walk me through an experience you had with GLOBE ONE? (S)

4. Why are you collecting the data that you are collecting? (S)

4.5. Do you know what the scientists are trying to find out? (S)

8. What do you like most about your school? (S)

9. What do you like least about your school? (S)

10. What do you like about GLOBE? (S)

11. Would you have been able to implement this protocol without the support of the group? (T)

12. In the past, what protocols have you implemented? (T)

13. In the past, what learning activities have you implemented with students? (T)

14. In the past, what other GLOBE-related activities have you conducted with students? (T)

15. Do you think you will continue to collect data after GLOBE ONE is over? Why or why not? (T)

16. Is there anything that surprised you that you learned about scientists? (T, S)

17. Have you had to adapt any of the protocols so your students can do them? (T) What about for different kinds of students (e.g., different achievement levels, special education)?