Explaining Implementation Variation and Fidelity in GLOBE:
An Analysis of Student Data Reporting Patterns

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Introduction: Variation in the Enactment of Educational Innovations

Researchers of educational innovations have long been concerned with studying variations in the implementation or enactment of educational innovations. Evaluators in particular have advocated the collection of data on within-program variability in program implementation, because the scale, depth, and fidelity of implementation can never be assumed ahead of time when designing an evaluation (Patton, 1979; Rossi & Freeman, 1989; Scheirer, 1994). Data on variation in program implementation are critical both in understanding the limits of a program's applicability or flexibility and in explaining within-innovation variations in effectiveness (Lipsey & Cordray, 2000). In addition, such data can help identify competing hypotheses for observed impacts (Schiller, 2001) and possible flaws in the assumptions that underlie the program design (see Goodson, Layzer, St. Pierre, Bernstein, & Lopez, 2000).

Researchers differ in their interpretations of the significance of implementation variation. Some are concerned with measuring implementation fidelity, that is, the extent to which teachers enact innovations in ways that either follow designers' intentions or that replicate practices developed elsewhere (Loucks, 1983). These researchers often cite evidence from large-scale studies of innovations such as the Comer School Development Program, Success for All, and the New American Schools scale-up that implementation fidelity is often strongly related to program effectiveness (Millsap, Change, Obeidallah, Perez-Smith, Brigham, Johnston, Cook & Hunt, 2000; Stringfield, Datnow, & Ross, 1998; Bodilly, 1998). Other researchers have argued that focusing on implementation fidelity ignores the important role that teachers play in adapting and transforming innovations to be effective in different contexts. They can point to evidence from studies of policy implementation that demonstrate the central importance of teachers' views and understandings of policy goals in shaping the outcomes of innovations (e.g., Cohen & Hill, 1998).

Few studies to date, however, provide a context for studying innovations where both variation and fidelity are important dimensions of implementation to designers. Earlier research has focused primarily on programs and innovations where reforms believed it was particularly valuable or important that teachers adhere to a particular design for teaching and learning (e.g., Stringfield, Datnow, & Ross, 1998). Alternately, research has examined curriculum adaptation and enactment in situations where co-development of the innovation with teachers was a part of the original design of the innovation (e.g., Brown & Edelson, 1998). There are, however, a number of innovations developed to encourage K-12 teachers to incorporate science resources and inquiry activities into their teaching that are concerned to some degree with both fidelity of implementation and teacher choice in the use of particular materials. The Full-Option Science System (FOSS), Science Education for Public Education Program (SEPUP), various regional and nation-wide "river watch" programs, and the program that is the subject of this paper, the Global Learning and Observations to Benefit the Environment (GLOBE) program are just a few such science inquiry initiatives.

Few of these programs, however, have to date collected much empirical data on whether and how the resources and instructional strategies promoted in the workshops actually get implemented in classrooms. The Global Learning and Observations to Benefit the Environment (or GLOBE) program provides an interesting context for examining issues concerning implementation of inquiry-oriented, scientist-driven educational programs, because the program has both a history of collecting evaluation data on implementation and mechanisms for capturing program activity as it occurs. As part of its evaluation activities, SRI International researchers have collected data from teachers about their own implementation practices and perceptions of the program; considered together with data on program activity collected by the program, analyzing GLOBE offers a rich opportunity to examine implementation both from the perspective of researchers who are interested in implementation fidelity and those who are concerned with describing program variation.

GLOBE as a Context for Studying the Enactment of Inquiry Science Teaching

GLOBE is an international environmental science and science education program focused on improving student understanding of science by involving young people in doing real science. The program involves elementary and secondary students worldwide in measuring characteristics of their local atmosphere, bodies of water, soil, and land cover. GLOBE scientists use student-collected data in their own investigations of such phenomena as the verification of remotely sensed global precipitation (Postawko, Morrissey, Greene, & Mirsky, 2001), accuracy assessment of Landsat images (Congalton, Rowe, & Becker, 2001), and modeling of relationships among Earth systems (Robin, Levine, & Riha, 2001).

Unlike many of the programs that have provided the context for studying fidelity of implementation (e.g., Bodilly, 1998; Millsap, Change, Obeidallah, Perez-Smith, Brigham, Johnston, Cook & Hunt, 2000; Stringfield, Datnow, & Ross, 1998), GLOBE's philosophy has always been one of providing resources and leaving decisions concerning curriculum and pedagogy to teachers. It therefore would be a mistake to treat GLOBE as a "program" in any strict sense, because teachers' adaptations shape GLOBE's potential to promote student learning in such fundamental ways. At the same time, because the premise of GLOBE is that students and teachers can collect scientifically useful data, GLOBE scientists are genuinely concerned with the fidelity of teachers' and students' implementation of the scientific data collection protocols and persistent and reliable reporting of the collected data. The shared repository for GLOBE data (the Student Data Archive) provides a record of every data submission going back to the program's beginning in 1995. Although nothing prevents teachers who have undergone GLOBE training from using GLOBE resources and learning activities without submitting data to the database, students' involvement in collecting and reporting scientific data is at the core of the GLOBE concept and we are able to track the extent to which teachers who have received training involve their students in these GLOBE activities.

Consistency and Persistence in GLOBE Implementation

Variation in data reporting within GLOBE can be measured along two dimensions: consistency and persistence. The GLOBE Student Data Archive provides a window into how GLOBE implementation at a school changes over time. SRI's teacher surveys are administered on an annual or biennial basis, but student data are collected and reported throughout the school year and can be compared across years. Using data reporting as an indicator, we can investigate *consistency* in GLOBE implementation in any given year, as well as *persistence* in GLOBE implementation from year to year.

To evaluate consistency of data reporting, we have defined two terms that are used throughout this paper. We refer to *periodic reporters* in any given year as schools that report one or two months out of the year.[1] We refer to *steady reporters* as schools that report seven or more months out of the year. We also present analyses of schools that fall in the middle, that is, schools that report data during three to six months out of the year, but many of the contrasts we draw focus on the implications of schools' being periodic versus steady reporters.

To evaluate persistence in data reporting, we have analyzed data reporting patterns in 2000-01 from schools that had reported data at least once in 1999-2000. Although we recognize that many schools may "skip" a year of data reporting, we wanted to have some reliable index, connected to our teacher survey data from Year 5 of the GLOBE evaluation, to better understand the factors associated with persistence in implementing GLOBE over time.

The remainder of this paper explores the relationships between consistency and persistence, as well as relationships between these variables and supports offered by the program providing GLOBE training and local conditions within the teacher's classroom and school. Our results underscore the significance of data reporting as an activity associated with persistence in the program, teachers' goals for GLOBE, and teachers' opportunities to learn about GLOBE after initial training for implementation fidelity.

Methodology

To investigate implementation fidelity and variation with respect to data reporting, we used data from the GLOBE Student Data Archive matched with survey data collected from a large sample of GLOBE teachers as part of SRI's Year 5 evaluation of GLOBE. The data used and analyses performed are described below.

Data Reports in 1999-2000. In spring 2000, SRI downloaded data from the GLOBE Student Data Archive that would allow researchers to create a file that showed school reports by month. A spreadsheet was created with columns to indicate whether a school reported data at all for each month between August 1999 and July 2000. Schools were then divided into four groups according to data reporting levels: nonreporters, periodic reporters (reported one or two months), average reporters (reported three to six months), and steady reporters (reported seven or more months).

Data Reports in 2000-01. The same procedure was used in July 2001 to download data reports by school for the 2000-01 school year. A spreadsheet was created with columns to indicate whether a school reported data at all for each month between August 2000 and July 2001.

[1] Periodic reporters are distinguished from nonreporting schools, which are registered as GLOBE schools but do not report data in a particular year.

Schools were then divided into the same four groups as were used for 1999-2000. This file was then merged with the file for data reporting in 1999-2000 and with data from the GLOBE database of schools that included information on whether schools were elementary or secondary schools.

Two primary analyses were conducted with these data. Analysis of the *consistency* of GLOBE implementation was conducted, using the proportion of reporters in each group from 2000-01 as an index. We conducted an analysis of the *persistence* in GLOBE by selecting those schools that had reported data in 1999-2000 from the file and comparing their 1999-2000 and 2000-01 reporting levels. The first part of the results section of this paper presents these findings for GLOBE schools overall, as well as for schools at different grade levels (elementary versus secondary). Because many schools' grade-levels are not indicated in the GLOBE database, the separate analyses by grade level involve much smaller samples and must be viewed with caution.

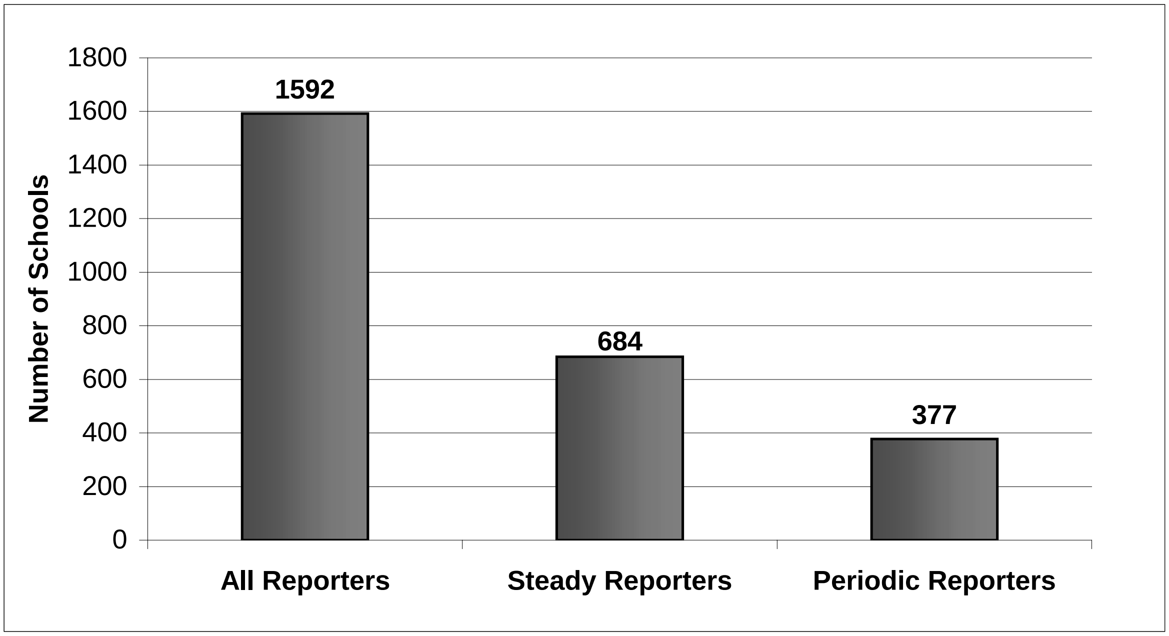
GLOBE Year 5 Teacher Survey Data. In the second part of the results section of this paper, we focus on understanding factors associated with variation in program implementation. For the analyses that form the basis of our discussion, we merged the data file we used to analyze consistency and persistence in GLOBE implementation with the data file of U.S. teacher survey responses we used in Year 5. This survey includes information about barriers to program implementation, as well as information about supports teachers accessed after GLOBE training. These data on barriers and supports were analyzed to determine whether there were significant relationships between specific barriers and supports and levels of data reporting. To test for the significance of the findings, in each case a chi-square test was used to determine whether the schools' data reporting levels were influenced by access to a particular post-training support or experienced with a particular factor as a barrier to implementing GLOBE. As part of our analyses for this paper, we also merged data on the number of GLOBE teachers at the school and the date when the newest GLOBE teacher at a school was trained, both of which may be factors affecting data reporting patterns.

Results

Periodic versus Steady Data-Reporting Schools in GLOBE

Of schools that report GLOBE data, many more are steady reporters than periodic reporters. In fact, in 1999-2000 and again in 2000-01, there were almost twice as many steady reporters (684) as periodic reporter (377), as shown in Figure 1.

Figure 1: Number of Steady and Periodic GLOBE Data Reporters in 2000-01*



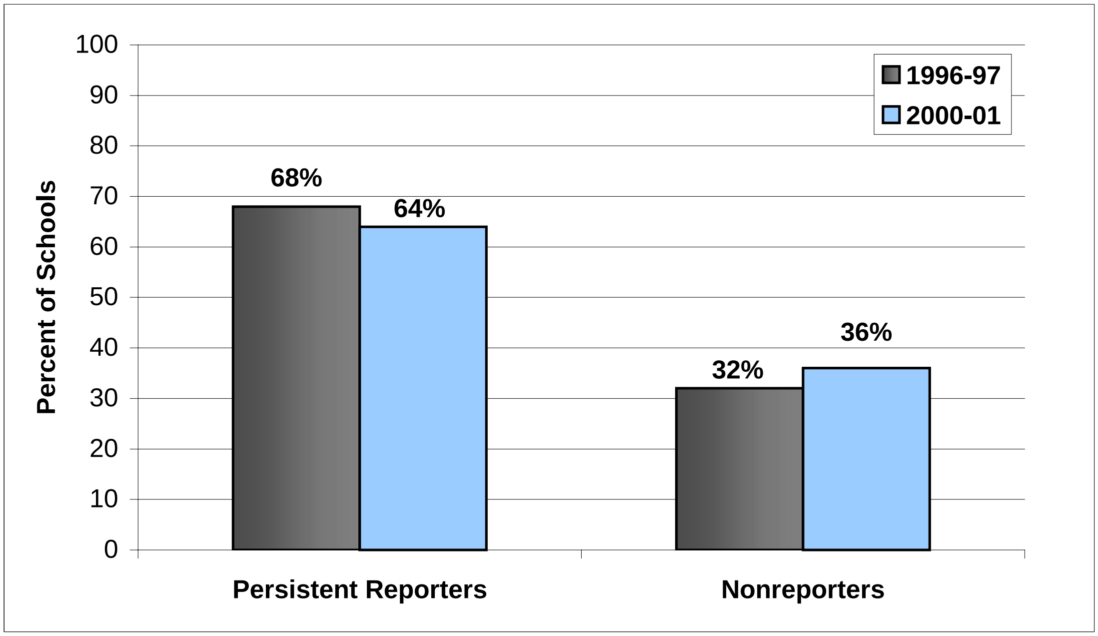
**Includes only schools that reported either in 1999-2000 or in 2000-01.*

Although many more elementary schools than secondary schools are steady reporters, the percentages of schools that are steady and periodic reporters at each grade level are representative of GLOBE implementation more broadly. In other words, it does not appear that elementary schools, for example, are disproportionately more likely than secondary schools to be steady reporters.

Persistence in GLOBE Data Reporting

In Year 2, SRI examined persistence in data reporting from the first to second year of GLOBE. During that period, 68% of all GLOBE schools that had reported data in 1995-96 reported again in 1996-97. Today, the percentage of schools that persist in reporting data from one year to the next is similar. As Figure 4.2 shows, about 64% of schools that reported data in 1999-2000 also reported in 2000-01. Figure 2 also shows that the proportion of nonreporters has not changed substantially since the beginning of the GLOBE program.

Figure 2: Persistence in GLOBE Data Reporting from 1999-2000 to 2000-2001

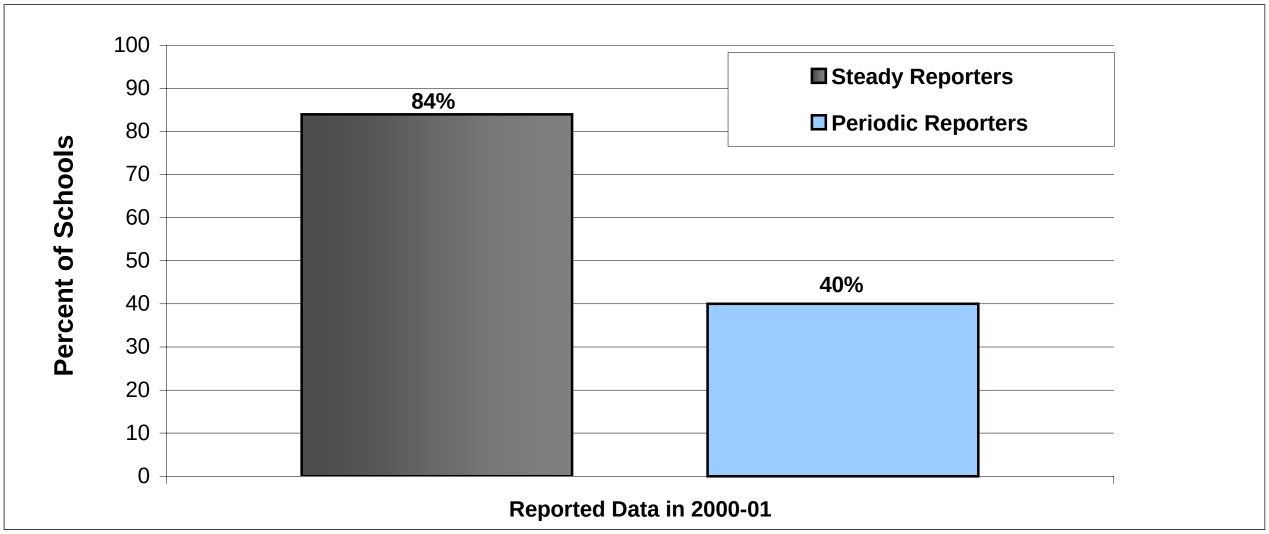


As with steady data reporting, it does not appear that elementary and secondary schools differ with respect to the likelihood that they will persist from year to year in reporting data.

The Relationship between Data Reporting Levels and Persistence

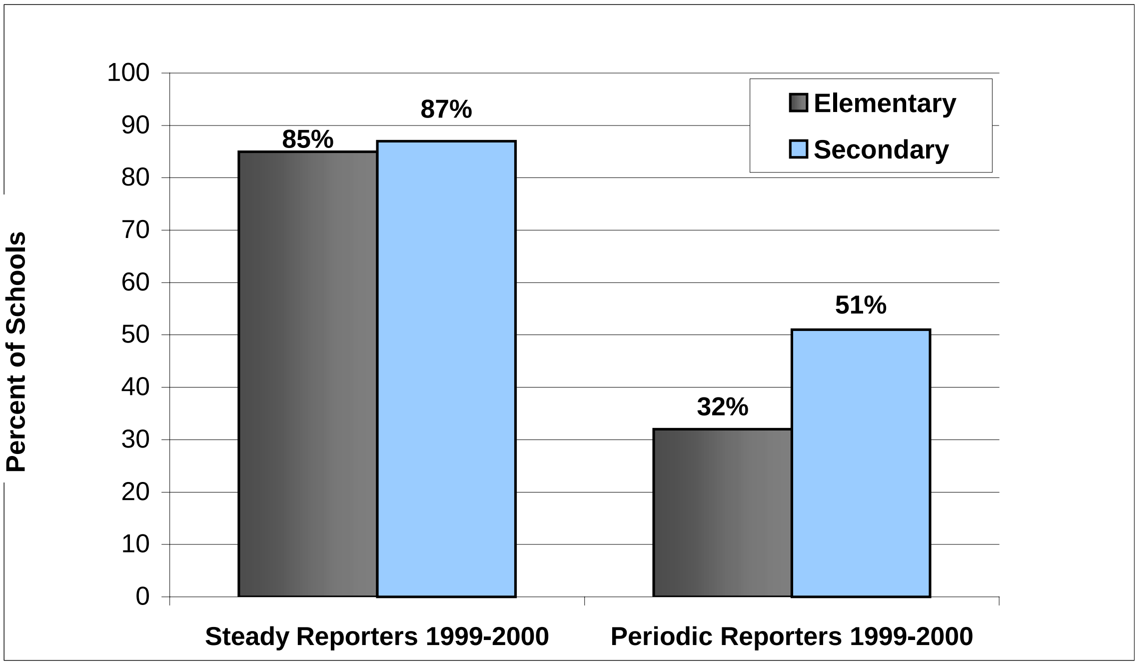
A closer examination of the GLOBE Student Data Archive shows that data reporting and persistence are closely related. In fact, schools that are steady reporters in one year are more than twice as likely as periodic reporters to report data the next year. More than four-fifths (84%) of the schools that were steady reporters in 1999-2000 reported data in 2000-01, compared with just two fifths (40%) of periodic reporters (Figure 3).

Figure 3: Persistence in GLOBE: Steady Reporters vs. Periodic Reporters



It appears that relationship between being a steady reporter and persistence in data reporting the following year is greater at the elementary level than at the secondary level. It may be more significant—in terms of predicting persistence in data reporting—for an elementary school to report data consistently than for a secondary school to report data consistently throughout the year. Whereas less than one-third of periodic reporters at the elementary level reported data the next year, just over half of secondary periodic reporters reported data the next year (Figure 4).

Figure 4: Persistence in GLOBE Data Reporting, by School Level



Impact of Posttraining Supports on GLOBE Data Reporting

Many GLOBE partners offer additional resources to teachers following their initial training sessions. These resources are intended to support teachers' efforts to implement GLOBE protocols and report data. They include:

- Communications through such methods as listservs, newsletters, meetings and conferences, and contact with GLOBE partner staff or other GLOBE teachers via telephone or e-mail.
- Mentoring during school visits by GLOBE partner staff or experienced GLOBE teachers.
- Supplementary materials, such as tips for implementation.
- Follow-up or refresher training sessions.
- Participation incentives, such as equipment or recognition for reporting certain types or amounts of data.

SRI used responses to the Year 5 teacher survey in an analysis of which supports are most likely to be associated with consistency and persistence in GLOBE data reporting. Table 1 presents two aspects of those results. First, it shows which supports are most frequently provided to teachers. The communications line at the top of the graph indicates that communication resources are most often provided, being available to 70% of respondents. Least often provided are incentives, the line at the bottom of the graph, which were available to 15% of respondents.

Table 1: Percent of Teachers Reporting Availability of Post-Training Support, by Number of Months Data Reported, 1999-2000

	Number of Months Data Reported				
Type of Support	0 (n=324)	1-2 (n=48)	3-6 (n=138)	7+ (n=281)	χ^2
Communications (e.g.,	69.8	64.6	69.6	74.4	2.90

newsletter)					
Mentoring	21.6	27.1	43.5	45.9	46.18***
Materials and Supplies	29.6	39.6	44.9	43.1	15.57***
Refresher Training	19.4	18.8	20.3	27.8	6.96
Participation incentives	9.9	4.2	21.0	23.1	26.99***

* $p < .001$

Table 1 also displays the relationship of supports provided to consistency of reporting in 1999-2000. From this table, we can infer which kinds of support were most important in predicting consistency in data reporting and which ones did not appear to make a difference. The difference between those who did not report data (nonreporters) and those who reported data for seven or more months (steady reporters) indicates which supports are likely to contribute to consistent data reporting. Of the supports available, mentoring, materials, and incentives appear to have a significant impact on data reporting. Of the respondents for whom mentoring support was available, fewer than a quarter (22%) were nonreporters, and almost half (46%) were steady reporters. Similarly, of those for whom supplementary materials were available, 30% were nonreporters, compared with 43% who were steady reporters. When incentives were available, 10% of respondents still did not report data, whereas 23% were steady reporters.[2] Communications activities did not appear to have a significant relationship to steady reporting.

Barriers to Data Reporting

An analysis of responses to the Year 5 teacher survey in relation to data reporting in both 1999-2000 and 2000-01[3] indicated that both nonreporters and steady reporters encounter the same barriers to reporting, but that some of these are having a much greater impact on nonreporters. The greatest difference in the impact of barriers to reporting is the difficulty teachers face in integrating GLOBE with the curriculum, although the difference appears greatest between steady reporters and all other reporters (Table 2). Fewer than half of steady reporters (48%) considered this a barrier, compared with more than three-quarters of nonreporters (77%).

Table 2: Pct Reporting Difficulty with Curriculum Integration, by Reporting Consistency

	Number of Months Data Reported				
	0 (n=137)	1-2 (n=27)	3-6 (n=102)	7+ (n=231)	χ^2
Curriculum integration is a barrier to implementing GLOBE	77.1	93.1	71.4	48.4	7.20
Curriculum integration is <u>not</u> a barrier to implementing GLOBE	22.9	6.9	18.6	51.6	

[2] Each of these differences was statistically significant at p<.05.
[3] Data from 1999-2000, the year of the full teacher survey, are presented in this section. Data from 2000-01, the year of the mini telephone survey, mirror those results.

Another commonly experienced barrier to reporting data is the difficulty teachers face in finding time to report data (Table 3). The pattern in the data suggests that for those teachers who were able to implement GLOBE at all, time was a factor in the level of data reporting. Of those schools reporting data just 1-2 months of the year, 81% of the teachers reported that finding time to report data was a barrier, compared with 59% of steady reporters.

Table 3 : Pct of Teachers Saying Difficulty Finding Time to Report Data is a Barrier, by Reporting Consistency

	Number of Months Data Reported				
	0 (n=81)	1-2 (n=26)	3-6 (n=63)	7+ (n=125)	χ^2
Finding time is a barrier to implementing GLOBE	63.0	81.8	69.8	59.2	13.36*
Finding time is <u>not</u> a barrier to implementing GLOBE	37.0	19.2	30.2	40.8	

* $p < .05$

One of the reasons teachers implement the GLOBE program is to teach students to take measurements accurately. For some teachers, this goal may influence their view of the value of reporting data. Some teachers believe that the value for their students lies in taking GLOBE measurements, not in reporting them. This belief again had more impact on nonreporters than on steady reporters (Table 4). One-quarter of nonreporters cited this as a reason for not reporting data, compared with just 9 percent of steady reporters.

Table 4: Pct of Teachers Saying Value Is in Taking (Not Reporting) Data, by Reporting Consistency

	Number of Months Data Reported				
	0 (n=78)	1-2 (n=27)	3-6 (n=63)	7+ (n=113)	χ^2
Value is in taking but not reporting data is a barrier to implementing GLOBE	25.6	22.2	21.6	8.8	16.83*
Value is in taking but not reporting data is <u>not</u> a barrier to implementing GLOBE	74.4	77.8	79.4	91.2	

* $p < .05$

A final barrier to reporting that affected nonreporters more than steady reporters is problems with Internet connectivity (Table 5). About 57 percent of nonreporters experienced these problems, compared with just over half of the steady reporters (52%). Although GLOBE schools have Internet connections, the convenience of access for a particular class and the reliability of the connection are persistent problems at many schools.

Table 5: Pct of Teachers Saying Difficulty with Internet Connection is a Barrier, by Reporting Consistency

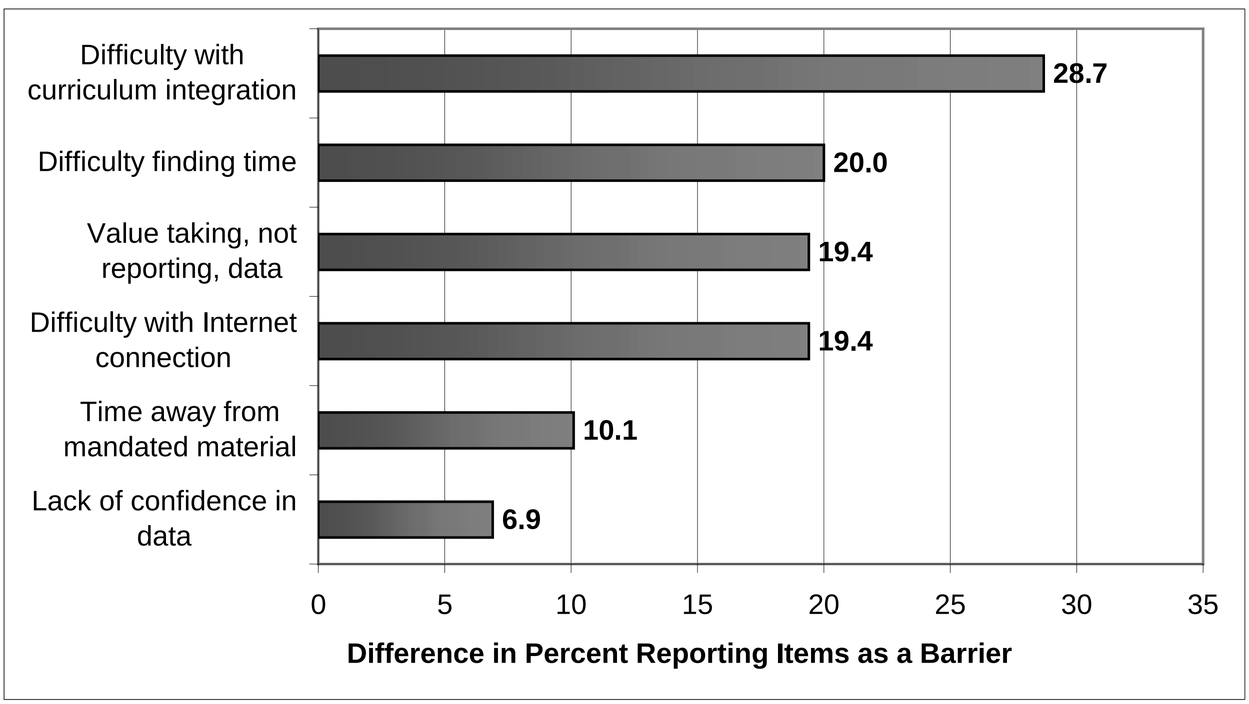
	Number of Months Data Reported				
	0 (n=85)	1-2 (n=28)	3-6 (n=64)	7+ (n=125)	χ^2
Difficulty with Internet connection is a barrier to implementing GLOBE	57.6	60.7	73.4	52.0	18.26**
Difficulty with Internet connection is <u>not</u> a barrier to implementing GLOBE	42.4	39.3	26.6	48.0	

** $p < .01$

Figure 4 displays these barriers together, showing the percentage difference between nonreporters and steady reporters. Each bar on the graph displays how much more impact the barrier had on nonreporters than on steady reporters. The display allows us to see the association of a particular barrier on consistency of data reporting. The largest associations are contributed by barriers in which the difference scores are greatest.

Although each of the barriers is experienced by both nonreporters and steady reporters, four of those barriers, have a much greater impact on nonreporters than on steady reporters: difficulty integrating GLOBE with their curriculum, finding time to report data, valuing the taking but not reporting of data, and difficulties with Internet connections.

Figure 4: Difference between Nonreporters and Steady Reporters, by Barriers to Reporting



These results are supported by independently conducted research that also investigated barriers to data reporting. Conroy (2001) analyzed lack of time as a barrier in greater detail and found that computer access is often at the heart of the time barrier. Teachers find it more difficult to report data when there are no computers for this purpose in their classrooms. Arranging to take some or all of the students to computers elsewhere, such as in a computer lab, is more complicated than sending students to computers within the classroom. Finding a convenient time to use computers outside the classroom is not always possible, especially in schools where there is a high demand for limited computer access.

Conroy also found that submitting data is not always valued as highly as data collection. Some teachers said that students find submitting data repetitive. Given that data reporting is also seen as time consuming, teachers find that they allow the level of student interest to influence the consistency of data reporting. Others said that collecting data for scientists is not necessarily a motivating aspect of the program for teachers. These results support SRI's findings and suggest areas to target in efforts to increase data reporting.

Discussion

One important finding from these data is that many schools do report data consistently, as GLOBE program designers intended. Nearly half of all schools that reported GLOBE data in Year 6 were steady reporters, submitting data during at least seven months from August 2000 through July 2001. Consistent student data reporting is necessary if GLOBE is to accomplish its educational and scientific mission of involving students in observing the environment in ways that can contribute to the advancement of science.

The analyses performed with data from the teacher survey and the Student Data Archive also underscore the significance of consistency in data reporting for persistence in GLOBE. Schools that report consistently in one year are twice as likely to report data again the next year, according to analyses of data reporting from 1999-2000 and 2000-01. Interestingly, this pattern is more pronounced among elementary schools than among secondary schools. An analysis of the Student Data Archive does not tell us why steady reporting seems to be less important at the secondary level, but differences between elementary and secondary curricula offer one possible explanation. Secondary teachers tend to be more tightly bound than elementary teachers by mandated curricula and by syllabi worked out well in advance. Secondary teachers may see GLOBE less as an opportunity to teach responsibility and consistent data reporting (a goal cited by many elementary teachers in a telephone survey) and more as an opportunity to illustrate a concept or deepen students' understanding of a particular scientific process as part of one unit of study within their syllabus. Therefore, secondary schools' "inconsistent" reporting of data may mask a consistency in teachers' using GLOBE to support particular topics each year in their curriculum.

The analyses examining the relationship between data reporting and post-training supports point to the central importance of mentoring and material support to teachers. Our finding that incentives, mentoring, and other on-site support to teachers have the greatest impact on data reporting levels suggests that GLOBE training providers may succeed in their efforts to sustain GLOBE teachers' involvement in the program by providing more access to such supports. At present, these supports are less common than listservs and e-mail communication with teachers after GLOBE training. In posttraining teacher mentorship programs, the close attention paid to local school contexts and how they shape possible forms of GLOBE implementation seem to pay off. The payoff, moreover, may help to shape teachers' pedagogical content knowledge with respect to implementing GLOBE in their particular schools and with their unique groups of students.

Implications

These analyses suggest that science-education collaborations can lead to teachers' implementation of science inquiry activities and suggest some of the factors that increase the likelihood of continuing implementation. These findings have practical implications for program design and improvement. Still, we believe it is important not to focus on the implementation of data collection and reporting activities to the exclusion of a broader view of what teachers and students are doing with GLOBE. For one thing, as articulated by the National Research Council (2000), science inquiry is a multifaceted undertaking, involving not just systematic data collection but question posing, the design of investigations, and analysis and interpretation of data as well. It is necessary to look at classroom practices more broadly to see whether or not data collection is taking place within a meaningful context. Secondly, researchers who examine only fidelity of implementation risk underestimating the importance of teachers' interpretations and actions in shaping the success of particular innovations. How particular programs and educational innovations unfold, in fact, is always negotiated within classrooms and schools (Datnow, Hubbard, & Mehan, 1998). Moreover, all reform is dependent upon the opportunities teachers have to learn how to enact the innovation, their interpretations of the innovation, and their actions to accomplish the goals of the innovation (McLaughlin, 1987; Cohen & Hill, 1998).

Researchers have sought alternative metaphors for describing program implementation that capture teachers' agency and the material and human resources teachers recruit as they work to integrate programs into their curriculum. For example, Sabelli and Dede (2001) refer to the *localization of innovation* as the process by which educators adapt and experiment with educational reforms. Other researchers have come to use the term *enactment* (e.g., Spillane, 1999; Cho, 1998) to describe the process by which teachers become aware of, construct, and operationalize reform designs. Although these metaphors suggest different lenses for understanding innovations, both metaphors privilege teachers' own adaptations of educational innovation. Both view teachers' adaptations not as problematic to the extent that they fail to be faithful to designers intentions; instead, teachers' adaptations constitute or make up the innovation as experienced by students.

Our case studies of classrooms of active GLOBE teachers have provided insights into the multitude of ways in which GLOBE can be enacted, and the features that tend to co-exist with steady and persistent data reporting (Center for Technology in Learning, 2000). Active classrooms tend to be situated in schools where the administration supports innovation in general and the GLOBE program in particular through recognition and encouragement, flexibility in the use of time, and the provision of resources. District and state curriculum frameworks and accountability systems that stress environmental science content and science inquiry processes facilitate more involvement in the program.

Classrooms with high rates of GLOBE data reporting are also characterized by a number of *teacher enactment activities* that support data collection but are not emphasized in GLOBE training. Teachers have been particularly successful in developing creative plans for collecting and reporting data. Where there are multiple GLOBE teachers in a school, teachers have split up responsibility for collecting and reporting data. In other cases, teachers have enlisted the support of teachers in other subject areas to assist with particular activities, like helping to design instruments such as clinometers for use in taking biometry measurements. By involving multiple teachers in GLOBE, the lead teachers at these schools were able to do more with the time they had available for GLOBE. These teachers were also able to leverage time with their students through strategies for classroom management. They set up structures for small-group work, with students taking on specific roles and rotating through those roles according to a schedule. Once this was done, students could execute multiple GLOBE activities simultaneously, with their teacher rotating from group to group to troubleshoot any problems or uncertainties that arose. These student groupings also leveraged student expertise and areas of high interest, giving a wide range of students the chance to contribute based on their "specialties."

In schools where students are gaining more extensive practice in conducting inquiry with GLOBE, teachers are providing extensive scaffolds for engaging in processes of scientific investigation. They actively coach students as they collect data to encourage accuracy of measurement and the use of scientific terminology to describe their procedures. In addition, these teachers do more than organize meaningful data collection activities: they help their students learn to pose questions about their observations and think about how data can form the basis for explanations of phenomena they observe. They also provide the larger science context of GLOBE to students, explaining to them how scientists use student data in their own investigations. In some cases, GLOBE students identify local environmental issues that can be investigated through GLOBE data collection activities. In one such instance, a GLOBE school was called on to collect data on water quality near a new local waste treatment facility, to address community concerns over the effect the facility might have on the local environment.

GLOBE implementation hinges on teachers' understanding of science inquiry. Our case studies suggest that teachers' own goals for their students' involvement in GLOBE, as well as their understanding of their students' capacities for learning, shape how they use GLOBE in the classroom. Their sense of the adequacy of GLOBE materials, and how they fit within the curriculum they are expected to teach and the content on which students will be tested, affects how and when they engage in data collection, data reporting, and other GLOBE activities. Finally, teachers' own school contexts shape the incentives they have to implement GLOBE to a greater or lesser extent; their willingness to be pioneers in GLOBE is similarly affected by how much support teachers have at school for what they are doing.

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