EARTH SCIENCE BY DESIGN

FIELD TEST EVALUATION STUDY REPORT

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Introduction and Overview

Earth Science by Design (ESBD) is a 3-year teacher enhancement project funded by the National Science Foundation. The main goal of the project has been to produce a Web site and handbook that would support staff developers in their efforts to enhance the capacity of middle school teachers of Earth science to:

- Teach for deeper, enduring understanding
- Teach to the big ideas in Earth and Space Science
- Use visualizations and satellite imagery to promote student understanding.

Year 1 of the project involved development of the ESBD professional development materials and the testing of those materials, their implementation, and the program implementation model in general with a cohort of teachers. Year 1 implementation was conducted by TERC and American Geological Institute (AGI) staff (the developers of the materials). Year 2 involved implementation, again by TERC and AGI, of the materials with a second cohort of teachers and involving Year 1 teachers as developers of the program. Finally, Year 3 of the ESBD project consisted of a field test of the ESBD professional development materials at eight sites nationally.

The key goals of the field test were to (1) test the project materials in a range of professional development contexts and with a wider population, (2) test whether the materials could be adopted effectively by experienced staff developers without specific training in how to implement the program. The purpose of the field test evaluation was to assess whether (1) field test teachers would report the same quality of professional development experience as did Year 2 teachers, (2) implementation of the program by staff developers at the field sites would compare favorably with implementation by ESBD developers, and (3) staff developers would rate ESBD professional materials as effective and plan to use them again.

This report presents findings from the field test evaluation study of the ESBD program. Following this introduction, the report contains three main sections. The first section provides results of a comparison of the field test teacher group with the Year 2 TERC group. The two groups are compared on their evaluations of summer institutes and their experiences and evaluations related to their implementation of their ESBD units and other aspects of the ESBD program. The next section presents data regarding staff developers' evaluation of the ESBD materials and program, and also reports on aspects of implementation of the ESBD program. The last section reports on further aspects of field test teachers' experiences in and evaluations of the ESBD materials and programs.

Field Test Evaluation Design and Data Sources

The goal of the Year 3 evaluation was to assess whether the field test sites could deliver the ESBD program as effectively as the ESBD staff[1] had done in Years 1 and 2. Investigation of this question involved two avenues of data collection and analysis: (1) a comparison of field test teachers' experiences and evaluation of the ESBD program with those of teachers who

[1] "ESBD staff" refers to the project team members from both TERC and AGI. In the sections that follow, ESBD staff will be referred to as TERC to avoid confusion between the ESBD program years.

participated in the ESBD program implemented by the program developers at TERC in Year 2. The investigation included teachers' evaluation of the summer institute during which they received training and teachers' evaluation of their own implementation of the units they developed as part of and based on that training, and (2) evaluation of the ESBD program and materials by seasoned staff developers who participated in the field test. Data bearing on these two lines of analysis were gathered through the following sources:

- An online summer institute evaluation questionnaire (Appendix B), also completed by teachers in Years 1 and 2 (Appendix A).
- An online implementation and peer observation questionnaire (Appendix D), also completed by teachers in Years 1 and 2.
- An online staff developer questionnaire (Appendix C), completed by staff at the eight field test sites.
- Telephone interviews with three field test site leaders.

Overview of Key Evaluation Findings

Overall, the field test sites delivered the ESBD program as well as ESBD staff; very slight differences in field test teachers' evaluation of the ESBD trainers were observed. Field test teachers' evaluations of the summer institutes they attended were very positive. Field test teachers' reports of their experiences in implementing ESBD units were also positive in terms of enhancement of their own skills and learning experiences for their students. Field test teachers were positive, overall, about the ESBD approach to instruction. In addition, the staff developers who used the ESBD materials were very positive in their evaluation of the ESBD materials and the model overall. Staff developers also reported a high degree of fidelity to the model and implementation of the ESBD materials.

Field Test Sites: Contexts, Staff, and Participants

Table 1 lists the field test sites, the number of staff developers at each site, and the number of teachers who participated in data collection activities for the evaluation of the ESBD program.

Table 1. Field Test Sites

Field Test Site	Number of staff	Number of respondents to final teacher survey*
Duval County Public Schools	2	11
Jackson County Math and Science Center	4	1
Missouri Botanical Garden	4	3
Oakland County Math and Science Center	4	4
Plymouth State University	2	8
San Diego County Office of Education	Unknown	4
Science Pioneers, Kansas City	3	9
Tucson Unified School District	5	6

* Field Test: N = 61
Missing: 15

From these sites, seven staff developers participated in a survey focused on evaluation of the ESBD program and materials. The survey was conducted after completion of the summer institutes and fall mini-conferences. The seven staff development professionals participating in the ESBD field test were a highly experienced group. All but one reported devoting 50% or

more of their time to professional development. Four reported 15 years or more experience in staff development, and the other three reported 4 to 7 years experience. Half of the staff developers reported considerable prior experience with conducting similar summer institutes. Three of the seven reported having some formal education in earth science, and six reported having a science educational background.

All sites had at least acceptable resources for the implementation of the ESBD program. Survey respondents described the staffing of their summer institutes as adequate. Table C-8 in Appendix C reports details regarding the summer institute staffing for each site. All sites reported a high level of technology quality, technology support, and technology access for participants, as well as adequate facilities. (See Tables C-16 to C-19 in Appendix C.)

ESBD Field Test Teacher Participants

Most field test sites had selection criteria for teachers who would be accepted to participate in the ESBD program. Following are the selection criteria reported by staff developers in the staff developer survey.

- Any teachers who qualified could participate.
- If they met baseline criteria (teach middle school, have some comfort with technology, and intend to implement the unit they design), they were accepted. We didn't exactly have an excess of applicants, though some were discouraged from applying if they were not middle school teachers or if they didn't intend to participate in the full institute. One pair, for example, wanted to tag team the institute and share what they learned back at school.
- If they met the criteria of teaching middle school and taught some earth science units; expressed a valid interest in teaching Earth science as part of professional growth.
- We only had 18 apply, 15 of whom could attend at the time of enrollment on the internet, and 12 who could attend…other had conflicts come up.
- I approached teachers through a database maintained by another organization reaching 45 school districts in the area. I tried to balance new and experienced teachers, from all areas of the district. If I invited them, they were accepted.
- Review of their application, teaching experience, and Earth science teaching responsibilities.
- We tried to develop pairs at middle schools for support but finally had to accept single teachers from half of the middle schools. We did not have more completed applications than we could handle.

All survey respondents reported a diverse mix of teacher participants in their individual ESBD programs. Table C-14 in Appendix C provides descriptions of participating teachers.

All sites but one compensated teachers monetarily for their participation. Most sites also provided participants some graduate or professional development education credits. The specific incentives reported were the following:

- $350 to attend and could pay $200 for 4 hours of graduate credit at [a] University.
- $500 stipend plus 45 hours of salary increment credit which means an additional $500 on the salary schedule.

- $750 stipend plus some materials beyond what ESBD provided, such as teaching units (GEMS Seasons), software (Riverside Scientific Seasons, Winds, Clouds, Storm Systems and New Moon) and a classroom watershed model.
- Minimally, a $200 stipend was paid at the end of the summer institute. Budget permitting, we will pay more at the end of the program. Several also took advantage of cut-rate graduate credit (about $75/credit for private college tuition).
- Stipend for the 2 week institute, part-time hourly to work on unit during personal time, $200 for equipment to support unit, and district pay of substitutes for peer visits. Teachers were also invited to attend a 3 day Understanding by Design workshop set up through our USI grant and the district last May.
- Teachers received the following: three graduate credits, lunch and snacks during the day, and a weekly evening cookout.
- Hours of credit to fulfill requirements of being certified in Earth science under No Child Left Behind.

Comparison of Field Test and TERC Teachers' Evaluations

Institute Evaluation Questionnaire Results

Overview

This section of the report presents data from the summer institute evaluation survey, comparing results from Year 2 teachers with Year 3 field test teachers. Year 2 teachers were trained by TERC who were responsible for developing the ESBD materials and who are experienced staff developers in Earth science. To test whether these materials could be used effectively by other professional staff developers with no specific training for implementation, eight staff development sites conducted the field test. The comparison of evaluations by teachers in the field test with evaluations by TERC teachers from Year 2 represents a critical test of the adequacy of the ESBD materials for wide adoption. Equivalent evaluations by the two groups provide strong evidence that the materials can be effectively implemented with no staff developer training for implementation, that the materials are effective with a wider population of teachers, and that the materials can be effectively implemented in a wide range of contexts for the provision of staff development.

Comparison of evaluation ratings by the two groups of teachers reveals that the field test teachers were highly satisfied with the training and the ESBD program as a whole, showing nearly the same ratings as those of the teachers in the Year 2 group.

In Year 2, during the final stage of development of the ESBD materials, 12 teachers completed the institute evaluation survey administered in July 2003. In Year 3, 66 teachers completed the evaluation survey (December 2004) of the same summer institute offered at eight field sites across the United States. Although minor, the differences in responses between the two trainings—with TERC or in the field—indicate that teachers in the TERC-led program rated the ESBD training slightly higher than did the field test teachers. Results will be reviewed before offering possible reasons for the differences identified.

Key Comparisons

Results from the field test teacher group were nearly identical to those of the TERC teacher group on the key dimensions of ESBD evaluation: overall evaluation of the ESBD program compared with other professional development programs, enhancement of skills and abilities through participation in the training program, and evaluation of preparation to implement ESBD strategies and lessons (see Appendix B).

Results presented in Table 2 show slightly higher ratings by TERC teachers of the ESBD program overall in comparison with other professional development programs. More significantly, however, teachers in both groups ranked their ESBD summer institute as among the best or best of all in comparison with other professional development.

Both TERC and field test teachers reported that the summer institute they participated in was effective in increasing their abilities in the areas listed in Table 3. Mean ratings for these areas were all above 3, or effective, and some were closer to 4, very effective. Field test teachers were

asked about their skill enhancement again in the implementation survey, and their responses were similar at that time.

Field test teachers, like TERC teachers, reported that they felt prepared to enact all the key dimensions of the ESBD model on completion of their summer institute. Table 4 presents teachers' ratings of how prepared they were to implement their ESBD units based on their experiences in the summer institute. For each of the items in Table 4, ratings for Year 2 (TERC) are slightly higher than those for the field test. However, ratings of 3 or 4 indicate that teachers described themselves as prepared or very prepared, respectively, to implement their units. Only three of the field test ratings fell slightly below 3. Similar results for these items will be presented later in this report for the field test teachers who answered this question once again in the implementation questionnaire.

Table 2. Teachers' Mean Ratings of Summer Institute Compared with Other Professional Development

	TERC	Field Test
Concern for student experience	3.42	3.24
Content	3.67	3.06
Quality of instruction	3.58	3.08
Practical value	3.83	3.23

Scale: Below average, Above average, Among the best 15%, Best of all
TERC: N =12
Missing: 0
Field Test: N = 66
Missing: 4, All Questions

Table 3. Teachers' Mean Ratings of Skills Enhancement after Summer Institute

	TERC	Field Test
Inform students at the beginning of the unit or course	3.58	3.37
Hook and hold students' interest	3.33	3.32
Use a variety of strategies to promote understanding	3.67	3.33
Facilitate students' active construction of meaning	3.50	3.22
Promote opportunities for students to 'reveal their thinking'	3.42	3.16
Use questioning, probing, and feedback	3.25	3.14
Teach in the context of big ideas and explore essential questions	3.58	3.35
Use information from ongoing assessments to adjust instruction	3.17	3.11
Use information from ongoing assessments to check student understanding	3.42	3.21
Use a variety of resources to promote understanding	3.67	3.56

Scale: Not effective, Somewhat effective, Effective, Very effective
TERC: N =12
Missing: 0
Field Test: N = 66
Missing: 3, All Questions

Table 4. Teachers' Mean Ratings of Preparedness after Summer Institute

	TERC	Field Test
Teach the 'big ideas' in Earth science	3.7	3.2
Use visualizations in teaching Earth science	3.3	3.3
Design learning experiences that address the big ideas	3.5	3.2
Design units according to the UbD principles and procedures	3.5	3.1
Design assessments to assess understanding	3.7	3.0
Design and apply rubrics for evaluating student work or performances	3.3	2.9
Use performance assessments	3.8	3.2
Analyze, evaluate, and provide feedback on the learning designs of peers	3.1	3.0
Discern and formulate topics 'worthy of understanding'	3.7	3.1
Use the WHERE framework to design instruction	3.6	3.1
Design curricula that addresses students' misconceptions	3.7	3.1
Design assessments to detect students' misconceptions	3.3	2.9
Use the notion of 'understanding' to guide instruction	3.7	3.1

Scale: Not prepared , Somewhat prepared, Prepared, Very prepared
TERC: N =12
Missing: 0
Field Test: N = 66
Missing: 3, All Questions

Institute Delivery and Content

Ratings for the effectiveness of specific elements of the summer institutes were again similar for the two groups of teachers (Table 5). A few of the mean ratings from the Field Test teachers were slightly higher than ratings from the TERC group (daily reflections, whole-group discussions, readings, and using visualizations), but again, most mean ratings were slightly higher for the TERC teachers.

Table 5. Teachers' Mean Ratings of Effectiveness of Teaching and Learning Strategies and Topics at Summer Institutes

	TERC	Field Test
Strategies		
Daily reflections	2.42	2.69
Whole-group discussions	2.92	3.40
Small-group discussions	3.67	3.50
Small group work and activities	3.83	3.44
Readings	2.58	2.82
Designing UbD units (small group work)	3.67	3.63
Topics		
Designing and using rubrics	3.08	2.58
Designing performance assessments (small group)	3.33	3.21
Using WHERE to design instruction	3.50	3.32
Addressing student misconceptions (preconceptions)	3.42	3.31
Using visualizations to enrich instruction	3.25	3.50

Scale: Not effective, Somewhat effective, Effective, Very effective
TERC: N =12,
Missing: 0
Field Test: N = 66
Missing: 4, All Questions

Table 6 presents teachers' ratings of various aspects of the summer institute delivery. Overall, the field test teachers indicated that they found aspects of the institute process satisfactory to very satisfactory, but once again, TERC teachers reported slightly higher levels of satisfaction.

Table 6. Teachers' Mean Satisfaction Ratings for Institute Process

	TERC	Field Test
Institute length	3.58	3.10
Institute daily scheduling	3.50	3.19
Pace of activities	3.58	2.95
Institute content overall	3.83	3.63
Use of audio-visual technology to support content	3.92	3.10
Meals and amenities	3.92	3.15
Classroom facilities	3.75	3.42
Laboratory facilities	3.50	3.27

Scale: Not satisfactory , Somewhat satisfactory, Satisfactory, Very satisfactory
TERC: N =12
Missing: 1, Question: Classroom Facilities
Field Test: N = 66
Missing: 4, All Questions

Both TERC and field test teachers' ratings of summer institute instructors and the support provided during the institute were very positive (Table 7). For this aspect of the institute evaluation, mean ratings from field test teachers were slightly higher for content difficulty and for interaction with fellow students.

Table 7. Teachers' Mean Ratings for Institute Instructors and Support

	TERC	Field Test
Knowledge level of instructors	3.83	3.56
Level of difficulty of institute content overall	3.08	3.11
Level of assistance provided with content	3.67	3.42
Level of interaction with instructors	3.75	3.69
Level of interaction with fellow students	3.58	3.81

Scale: Helped very little, Helped somewhat, Helped, Helped very much
TERC: N =12
Missing: 1, Question: Level of difficulty of institute content overall
Field Test: N = 66
Missing: 4, All Questions

Greater differences existed in the reports of TERC versus field test teachers regarding the probability of potential barriers to implementation, with field test teachers reporting fewer barriers to successful implementation than TERC teachers (Table 8). All but one mean rating for TERC teachers (planning time) ranged from a major barrier to a minor barrier. In contrast, all but one mean rating for field test teachers (also planning time) ranged between a minor barrier and not a barrier.

Table 8. Teachers' Mean Ratings for Possible Barriers to ESBD Unit Implementation

	TERC	Field Test
Support for implementation from my school principal/chief administrator	1.25	2.78
Support for implementation from my department head	1.17	2.83
Support for devoting more time to a single topic (less content topic coverage)	1.58	2.30
Planning time before and during implementation of my UbD unit	2.08	1.86
My understanding of how to implement UbD units	1.17	2.62
My proficiency in using technology visualizations	1.67	2.49
Access to computers	1.75	2.29
The knowledge level of my students	1.33	2.25
The interest level of my students	1.58	2.41

Scale: A major barrier, A minor barrier, Not a barrier
TERC: N =12
Missing: 1, Question: The knowledge level of my students
Field Test: N = 66
Missing: 3, All Questions

These data also provide evidence about the scalability of ESBD to a range of teacher and school populations. The differences in ratings suggest that teachers in the TERC group had somewhat more favorable conditions for adoption than the general population; adoption within the wider population is likely to be more vulnerable to a range of potential variables.

Discussion

Taken as a whole, group differences in evaluation of the ESBD summer institutes were extremely minor. This finding provides strong evidence that the ESBD professional development package can be successfully transferred to other sites and that results similar to those achieved by TERC can be attained by staff developers working in a variety of contexts with a variety of teacher groups.

Two general reasons for the minor differences in summer institute evaluation ratings are probable. First, instructors across field test sites vary in their Earth science content expertise, although all are experienced or highly experienced their roles (see Appendix C, Table C-4). Also, at the time of the field site institutes, staff developers were less familiar with the ESBD materials than were the TERC staff who developed those materials. The first sites to offer summer institutes (i.e., in late June rather than August) had less time to review materials before using them because final refinements were still being made by ESBD staff. One instructor noted that he "received the facilitator's guide for week 2 at the start of week 2." Second, participant buy-in to the ESBD institute training may have been higher for the TERC-led training if the teachers perceived a strong commitment of the staff to engaging them in a highly productive program and felt a commitment themselves to being part of a program in its early stages.

Unit Implementation Questionnaire Results

Another test of the adequacy of the ESBD professional development materials for wide adoption without staff developer training is whether teachers trained in ESBD at field test sites can attain unit implementation results similar to those achieved by teachers trained by the TERC and AGI staff who developed the ESBD professional development materials (see

Appendix D). The next section reviews comparisons between the two groups of teachers that are key to evaluating the success of the ESBD program; it is followed by a section reviewing other comparisons that are important for evaluating the field test.

Ten Year 2 TERC teachers completed the unit implementation survey in spring 2004, and 61 teachers completed the survey in spring 2005 (field test teachers) at the conclusion of the field test implementation year. Overall, teacher reports from both groups indicate field test teachers' ratings of satisfaction with and perceived effectiveness of the units they implemented were equivalent to TERC teachers' ratings of satisfaction and perceived effectiveness.

Key Comparisons

Teachers' ratings of their overall satisfaction with the ESBD units they developed, the instructional effectiveness of their ESBD units, the impact of ESBD on their instructional practices, and students' engagement during the ESBD units are the most informative and revealing dimensions of teachers' evaluation of ESBD in judging the success of the scaled-up implementation of the ESBD program.

Although teachers in both groups reported a range of challenges in preparing and implementing their ESBD units (see below), almost three-quarters (44) of field test teachers rated their units as satisfactory or very satisfactory. All but one of the 10 TERC teachers similarly were satisfied or very satisfied with their units (see Table 9). Thus, field test teachers were as satisfied with their ESBD units as were TERC teachers. The two groups of teachers were very similar in their perceptions of the instructional effectiveness of their ESBD units, relative to other approaches they have used to cover the same content: most teachers rated their units as more effective or much more effective than other approaches they have used (TERC: 80%, Field Test: 89%; see Table 10).

Field test teachers were very similar to TERC teachers in reporting on the beneficial effects of ESBD participation on their instructional practices (see Table 11). Likewise, field test teachers were nearly identical to TERC teachers in rating students' level of engagement during ESBD units. Teachers in both groups reported that their students appeared to be engaged during their ESBD units, with the field test group reporting a slightly higher mean rating of engagement (3.53 vs. 3.10). Most teachers in both groups rated their students as engaged or very engaged (TERC: 90%, Field Test: 89%; see Table 12).

Table 9. Teachers' Ratings of Overall Satisfaction with ESBD Units

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
Not satisfactory	3.30	0	3.09	2
Somewhat satisfactory		1		12
Satisfactory		5		23
Very satisfactory		4		21

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 3

Table 10. Teachers' Ratings of Unit Effectiveness

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
Not as effective	3.60	0	3.32	1
Moderately more effective		1		8
More effective		3		22
Much more effective		5		22
Not applicable		1		3

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 5

Table 11. Teachers' Mean Ratings of Influence of Participation in ESBD on Teaching Practices

	TERC	Field Test
Use of Understanding by Design unit planning techniques	4.0	3.6
Use of Understanding by Design teaching techniques	3.7	3.5
Incorporation or design of formative assessment	2.8	3.4
Integration of computer-based visualizations and images	3.2	3.5
Integration of online resources and tools (other than images and graphics)	2.8	3.4
Greater understanding of Earth science content	2.7	3.3
Instructional effectiveness in general	3.4	3.5

Scale: Not at all, Slightly, Somewhat, A great deal
TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 6

Table 12. Teachers' Ratings of Level of Student Engagement During ESBD Unit

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
Students did not appear to be engaged	3.10	0	3.53	0
Students appeared to be somewhat engaged		1		1
Students appeared to be engaged		7		24
Students appeared to be very engaged		2		30

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 6

Other Comparisons

This section presents data for comparisons in addition to the key comparisons reported above. These other comparisons are also important for evaluating the ESBD field test. They include questionnaire results for teacher reports of preparation to implement their units, difficulties encountered in preparing and implementing ESBD units, ESBD unit duration and perceived effectiveness relative to duration, the importance of technology in the ESBD units

implemented, experiences participating in peer observation, and satisfaction with support received during the year from staff developers. The two groups of teachers were very similar on all dimensions.

Time required to implement ESBD units was identified during the materials development and pilot-testing phases of the project as a major challenge to teachers' adoption of the ESBD approach. Both groups of teachers reported that the duration of their units was slightly or significantly longer than their usual approach (TERC: 80%, Field Test: 75%; see Table 13). All of the TERC teachers reported that the effectiveness of their units offset the time required (Table 14), as did 74% of field test teachers. However, 16% of field test teachers reported that their units' effectiveness offset time required somewhat, but not sufficiently. For both groups, almost all teachers reported that their units addressed content that they typically taught (TERC: 80%, Field Test: 89%) and that they planned to use their units again (TERC: 100%, Field Test: 89%).

Table 13. Teachers' Ratings of ESBD Unit Duration Compared with Other Approaches

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
Not as much time	3.30	1	3.11	3
About the same amount of time		1		8
Slightly more time		2		26
Significantly more time		6		20

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 4

Table 14. Teachers' Evaluation of Whether Instructional Effectiveness of Unit Offset its Time Requirement

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
No	3.40	0	3.11	2
Somewhat but not sufficiently		0		10
Sufficiently		6		25
Greatly		4		20

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 4

In terms of difficulties encountered in preparing to implement their units, both groups of teachers reported similar experiences (Table 15). The difficulty reported most often by both groups was finding time to prepare the unit, followed by either needing to deepen content knowledge (field test teachers) or experiencing uncertainty related to assessment (TERC teachers). Both groups reported that the greatest difficulty faced in implementing their units was not having enough time for the unit overall (Table 16). Both groups of teachers reported favorably on the adequacy of their preparation for unit implementation. Most teachers in both groups rated themselves as sufficiently or greatly prepared (TERC: 90%, Field Test: 82%; see Table 17).

Table 15. Teachers' Reports of Occurrence of Difficulties in *Preparing to Implement* ESBD Unit

	TERC		Field Test	
	Yes	No	Yes	No
Finding time to prepare the unit	8	2	44	17
Obtaining funds needed for materials	0	10	10	51
Needing to deepen content knowledge in order to complete the unit	4	6	30	31
Gaining support from colleagues	0	10	9	52
Gaining support from school administration	0	10	7	54
Experiencing uncertainty related to student assessments	5	5	26	35

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 0

Table 16. Teachers' Reports of Occurrence of Difficulties in *Implementing* ESBD Unit

	TERC		Field Test	
	Yes	No	Yes	No
Not enough time during class periods	2	8	25	36
Not enough time for the unit overall	6	4	29	32
Lack of student engagement	2	8	6	55
Lack of experience with UbD	2	8	20	41
Uncertainty about how to use data from the assessments	1	9	10	51
Lack of administrative support	0	10	3	58

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 0

Table 17: Teachers' Ratings of Extent of Preparation for Unit Implementation

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
No	3.20	0	3.25	0
Somewhat but not sufficiently		1		7
Sufficiently		6		29
Greatly		3		21

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 4

Mean ratings for satisfaction with support provided by training staff were very similar for both TERC and field test teachers. The mean rating for both groups of teachers was in the satisfied to very satisfied range. Tables 18 and 19 present ratings regarding support.

Table 18. Teachers' Mean Ratings of Satisfaction with Support from TERC and Field Test Staff

	Mean	
	TERC	Field Test
Specific feedback about revising your unit	3.3	3.3
Practical support and advice for creating or implementing your unit	3.2	3.4
Social/emotional support for the challenge of unit implementation	3.2	3.5

Scale: Not satisfactory, Somewhat satisfactory, Satisfactory, Very satisfactory
TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 6

Table 19. Teachers' Mean Ratings of Importance of Time and Support during Fall Mini-Conference

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
Not important	2.70	0	3.17	4
Somewhat important		6		8
Important		1		21
Very important		3		26

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 2

Use of technology was more important to the units of field test teachers than to those of the TERC teachers (Table 20). More than three-quarters (47) of field test teachers ranked technology use as moderately important or essential to the unit's success. In comparison, more than half (6) of TERC teachers rated technology use as minimally important.

Table 20. Teachers' Ratings of Level of Importance of Technology Use for Success of ESBD Unit

	TERC		Field Test	
	Mean	Frequency	Mean	Frequency
Technology not needed	3.30	0	3.28	4
Minimally important		6		8
Moderately important		1		21
Essential to unit's success		3		26

TERC: N =10
Missing: 0
Field Test: N = 61
Missing: 2

Peer observation is an important dimension of teachers' ESBD participation. Teachers were asked to rate their comfort with and preparation to participate in peer observation. Although ratings were very similar for the two groups (Table 21), fewer than half (22) of field test teachers responded to this item.

Table 21. Teachers' Ratings for Peer Observation Experiences

	TERC	Field Test
Teachers' ratings of own preparedness for observation	3.1	2.4
Teachers' ratings of own comfort level in providing feedback	3.1	3.1
Teachers' ratings of partners' preparedness for observation	3.3	2.9
Teachers' ratings of comfort level in being observed	3.7	3.4
Teachers' ratings of usefulness of feedback received	2.7	3.0

Scale: Not at all prepared/comfortable/useful, Moderately prepared/comfortable/useful, Prepared/Comfortable/Useful, Very well prepared/Very comfortable/useful

TERC: N = 9
Missing: 1
Field Test: N = 61
Missing: 39

Staff Developers' Evaluation of ESBD Materials and Program

Overview

A key goal of the field test was to have the ESBD materials evaluated on the basis of use by experienced staff developers working in a variety of institutional contexts nationwide, with various populations of teachers. Another key goal was to evaluate the scalability of the materials; we sought to determine whether staff developers at the field test sites were successful in implementing the program and whether they were likely to continue to use it after the field test.

Staff at field test sites were asked to complete an online survey in August 2004, after they implemented summer institutes with teachers. The survey queried staff developers about their experiences with and views of the ESBD materials, as well as their appraisal of the program model and their plans for future implementation.

Overall, staff developers' responses indicated a high level of satisfaction with and appreciation of the materials and approach of the ESBD program. They used the materials with few modifications or additions, though they sometimes altered the agenda provided to spend more or less time on topics as they sought to ensure teachers' understanding of the content being covered. The field test sites that were first to hold their institutes had less preparation time than sites that held institutes later, but their own and teacher reports indicated that they managed to implement the program well despite this difference. And, most importantly, responses indicated that teachers benefited from their experience with the ESBD program.

In telephone interviews in July 2004 with the leaders at three of the field test sites, comments echoed those of the staff developers in the questionnaires. The leaders saw the program as effective and as one that met their goals for teacher professional development. Only one of the leaders was unsure whether the program would be used again; that leader needed to find funds to offer ESBD again.

Staff Developers' Evaluation of ESBD Materials

Included in the ESBD materials are video excerpts from teachers discussing their experiences in learning about and implementing the ESBD approach to earth science instruction. The videos were made during Year 2 of the ESBD project, when a subset of participating teachers were videotaped describing their experiences with the program. Staff developers' responses (Table 22) indicated that the vignettes were highly effective. As hoped, staff developers reported that field test teachers valued the opportunity to hear about the real-life experiences of other teachers in the ESBD program, grounding in the classroom what they were learning from their trainers.

Similarly, the ESBD handbook received favorable ratings from staff developers (Tables 23 and 24). On all but two dimensions, all staff developers agreed either somewhat or strongly that the handbook was effective (Table 23). In comparison with other professional development handbooks, the ESBD handbook was rated as more effective by more than half of respondents (4), with an additional two staff developers rating it about as effective (Table 24). In terms of improvements to the ESBD handbook, staff developers made suggestions for additional

material, improving appearance, and adjusting the timing of content coverage during the summer institute (Table 25).

The online unit planner was rated favorably by staff developers for its role in helping teachers to design their units (Table 26). Two staff developers disagreed somewhat that the planner was easy for teachers to access and use. Suggestions for improvement included both desired additional features and options and indications of problems encountered (Table 27).

Overall, staff developers reported that the ESBD materials were effective and used as provided with minor changes (Table 28). Taken in conjunction with the results reported above, ESBD materials played an important part in the success of the ESBD field test.

Table 22. Staff Developers' Comments about the Utility of ESBD Videos

Response:	Although I was not initially confident that the videos would be useful, I must admit that the teachers did learn a lot from the interview sessions. The fact that they were only 9 minutes was beneficial. The teachers learned a lot from these.
Response:	I think they were useful because it put a human face on the program, and because the teachers in the video had many of the same concerns and issues that our teachers were having. It's always good to hear discourse on professional practice that is at a very high level. It raises the bar. Makes us more aware of ourselves as professionals and more intentional about improving.
Response:	I wasn't present when the videos were shown. My co-facilitators did this part of the agenda.
Response:	They were useful because our participants had a chance to hear others comment about the ESBD model.
Response:	They were useful in provoking very thoughtful discussions (both the intended videos and the ones we showed in error!) Seriously, they resonated well with the teachers, and really contributed to their ability to firm up their growing comfort with the ESBD/UbD approach to unit design.
Response:	They were useful in that the participants were able to hear from someone else who had experienced the process. But the people talked too fast and sounded like a prepared commercial.
Response:	We both felt they were useful for what they did say. We also felt that our participants wanted to hear more about how early implementers had struggled with learning the process, not so much about the actual implementation. Maybe add an earlier video concerning these issues too.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 23. Staff Developers' Ratings of Effectiveness of the ESBD Handbook

	Mean	Frequency			
		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
Offered complete information and resources for instructors' preparation before implementation	3.29	0	1	3	3
Presented adequate instructions and strategies for instructors' implementation of the activities each day	3.71	0	0	2	5
Clearly presented learning objectives and activities for each day and week	3.71	0	0	2	5
Offered complete activities and experiences for teacher-participants to master the targeted concepts and skills	3.43	0	1	2	4
Was effective in helping this organization achieve the objectives for teachers' professional development for which it [ESBD] was implemented	3.57	0	0	3	4
Provided an appropriate level of detail	3.57	0	0	3	4
Was well organized	3.71	0	0	2	5
Was easy to use	3.43	0	0	4	3
Attractively displayed information	3.43	0	0	4	3

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 24. Staff Developers' Ratings of the ESBD Handbook in Comparison with Other Professional Development Handbooks

Mean	Frequency			
	Less Effective	About as effective	More effective	The best I've used
2.67	0	2	4	0

Mean and Frequencies
Field Test: N = 7
Missing: 0

Table 25. Staff Developers' Suggestions to Improve the ESBD Handbook

Response:	Being an early implementer we often did not have all the resources until just prior to use. We also felt that the UbD book should be used if only as a reference that visibly helped to tie the program together.
Response:	I think more earth science content dealing with Earth as a system needs to be addressed.
Response:	In general, it did a very good job of supporting implementation. Since this was a field test, the level of prescriptiveness was no doubt deliberate. In public dissemination, adding options and extensions might be helpful. Also, as a minor matter of appearance, varying the fonts etc. for some aspects might help (e.g. web sites on p. 135).
Response:	Please see daily site reflections. There were several parts missing from the handbook that we had to create.
Response:	Too much time was devoted to the Rock Cycle as an example. Teachers already understood the model and were ready to move on.
Response:	We needed to add a more sophisticated way for teachers to review and analyze the scope and sequence of the teaching activities in their units. The analysis form you provided was too general, mostly listing the steps of WHERE without asking the teachers to critique their materials or look at how they fit together.
Response:	We were given two books, the Wiggins and McTighe, and the Dr. Art, but there were no indications of when the participants should read them. Ideally, the books would be read ahead of time by everyone, so that during the workshop, some degree of basic understanding would be there already. I felt the first two days were too crowded and we weren't able to do the topics justice.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 26. Staff Developers' Ratings of the Effectiveness of Online Unit Planner

	Mean	Frequency			
		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
Was easy for teachers to access	3.29	0	2	1	4
Was easy for teachers to use	3.00	0	2	3	2
Helped the teachers to design their units	3.57	0	0	3	4

Mean and Frequencies
Field Test: N = 7
Missing: 0

Table 27. Staff Developers' Suggestions to Improve the Online Unit Planner

Response:	Compared with UbD Exchange, this was much more user-friendly. I would suggest offering access to a wider pool of units as the project achieves a critical mass of teachers.
Response:	It needs to have expanding sections because participants ran out of space on some sections. Participants would sometimes not be able to get their units or got other people's units!!
Response:	Most teachers had few problems. Sometimes items were lost but I'm not sure who was responsible. Teachers indicated the desire to be able to put tables directly into their units along with cutting and pasting from word.
Response:	Needed a way to import a table and graphics into the unit plan.
Response:	Sections should not be broken up; the teachers should be able to scroll from one section to the other, rather than closing down. More frequent reminders to save before closing would also be useful. I think there wasn't a format for the rubrics (?)
Response:	They had problems using the software. We had to call several times for instructions

Open-Ended Responses
Field Test: N = 7
Missing: 1

Table 28. Staff Developers' Comments about Adjustments Made to ESBD Materials

Response:	Adjustments were minor. We felt that the materials and activities you provided were great and helped the teachers with their growth. We might recommend using the UbD book or workbook more in the future.
Response:	No major ones, except for inadvertently not using the correct reflections video.
Response:	Please see daily site reflections.
Response:	Stated earlier and in reflections and in the phone conversation with external evaluator.
Response:	We had to add time and then shorten time allotted to the topics. We followed the script almost exactly, but modified the times.
Response:	We related the model to the [State] Science Benchmarks that the teachers would be required to implement in their units.
Response:	We shortened the rock cycle activities because the teachers understood the process without belaboring the point. During the second week, we found the teachers needed an intellectual break from writing and thinking about their units. We went on a field trip with a state geologist and discussed some real geological processes.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Staff Developers' Evaluation of ESBD Program

A key question about the scalability of the ESBD program is whether it can be implemented effectively and faithfully without prior training for providers who implement the materials. Therefore, on the questionnaire, staff developers were asked whether they thought their implementation might have been more effective if they had received training or if training would have added other value. In addition, they were asked to report their overall satisfaction with their implementation of the program.

Most staff developers stated they would have appreciated having a half-day orientation to the program (Table 30) if that had been possible, and that prior training might have helped them to better anticipate teachers' questions and needs and provided better grounding in the materials. At the same time, however, staff developers reported that they were either satisfied

or very satisfied with implementation of the ESBD program during their summer institutes (Table 29); and overall, they reported that their summer institutes went well but noted some difficulties encountered (Table 31).

Table 29. Staff Developers' Ratings of Satisfaction with ESBD Program Implementation

Mean	Frequency			
	Not satisfied	Somewhat satisfied	Satisfied	Very satisfied
3.57	0	0	3	4

Mean and Frequencies
Field Test: N=7
Missing: 0

Table 30. Staff Developers' Comments about the Value of ESBD Prior Training

Response:	A half-day might have helped to provide a general orientation to what each day would accomplish. We spent several days going through the agenda thoroughly, assigning roles to each presenter, making sure materials were available, etc. and we would still need to do this even with a half-day orientation, although we might have gone through things more quickly with the orientation. For example, there were connections between certain days that we didn't see at first and had to figure out as we went along. Also, not having the finalized version of the agenda until right before the workshop made the preparation a little more difficult.
Response:	A one-day session would be most helpful to review the specific goals and review the UbD format and ESBD focus using UbD.
Response:	In our case, I'm not sure it would be important. We met as a staff for a few hours before the institute, and had intermittent team meetings as needed throughout the institute, which seemed sufficient. If we didn't have previous working relationships, this might have been more of an issue.
Response:	We devoted all the time we needed for preparation as part of our normal schedule.
Response:	We would have been able to anticipate more. Both [other staff member] and I can't imagine how one could adequately facilitate this institute without prior training in UbD. We often relied on our prior knowledge in this area to help our participants make meaningful connections. My personal experiences assisted me with the Earth Systems Science. Prior training would help but the duration is questionable. For us, if we had had a half day we would have only dealt with implementation issues, not the deeper applications issues.
Response:	The backward design is such a valuable process, that I wish we had been able to learn more about it ahead of time.
Response:	Yes, prior training would have been very beneficial. Especially on unit examples.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 31. Staff Developers' Impressions of Program Implementation

Response:	For what we had, it went very well. The low numbers limited the richness of diverse voices, but it was clear by the end that the institute had a significant impact on teachers' perceptions and approaches to curriculum. We'll see how this impacts practice.
Response:	I was quite pleased at the level of work the teachers accomplished. Once they understand the various components of the UbD format, they were able to really think about what they were doing. Ten intense days in a row is somewhat stressful, although I am not sure how to change this intensity other than to extend the time period. Teachers needed more time to 'digest' the content and UbD format.
Response:	It went very well. Teachers were satisfied with the content, the activities, and the relationships they built with each other. They are looking forward to the continued work in fall and winter. They also greatly appreciated the depth of knowledge, examples, resources, and materials that our geology professor, provided.
Response:	The teachers went from confusion and discomfort to a greater level of comfort in using the understanding by design process. Most of it went well. A few of the presentations were not as effective as they could have been, and time was not always sufficient for all topics.
Response:	We saw quite a bit of teacher growth in many of the participants. Teachers felt empowered to finish their units when they left. They felt a real sense of accomplishment. Many days our timing was off so we often wonder if we did not present everything in adequate depth.
Response:	We were very pleased with the program. Especially the attitude of the teachers. The online connections with TERC were very helpful and supported the institute very well.
Response:	Please refer to daily site reflections.

Open-Ended Responses
Field Test: N = 7
Missing: 0

In terms of enhancing teachers' skills, staff developers rated their summer institutes as effective or very effective (Table 32), with only one developer rating each of designing and using rubrics and using assessments formatively as somewhat effective. The staff developers also characterized teachers' response to their institutes as positive, noting that the teachers appeared to value what they had learned (Table 33). About half of the staff developers noted that the ESBD program is not appropriate for some teachers (Table 34), specifically those who are not interested in changing their instructional approach. The others indicated that they saw the program as suitable for all teachers.

Table 32. Staff Developers' Ratings of Teachers' Skills Enhancement

	Mean	Frequency			
		Ineffective	Somewhat effective	Effective	Very effective
Apply the Understanding by Design approach	3.57	0	0	3	4
Understand the "Big Ideas" in Earth science	3.29	0	0	5	2
Evaluate visualizations and use them effectively in teaching	3.57	0	0	3	4
Design and use performance assessments	3.14	0	0	6	1
Design and use rubrics for performance assessments	3.00	0	1	5	1
Use assessments formatively to modify teaching and guide student learning	2.86	0	1	4	1
Construct a sequence of learning activities using the WHERE model	3.29	0	0	5	2

Mean and Frequencies
Field Test: N = 7
Missing: 0

Table 33. Staff Developers' Characterization of Teachers' Response to ESBD

Response:	Everyone had a very positive response to the program. I think they valued most the organizational method they learned.
Response:	I think teachers really valued having two weeks to really focus on one unit. I think they valued learning the backward design process. I think the interaction with other teachers was positive.
Response:	I think they thoroughly enjoyed the program.
Response:	Our teachers were very positive and appreciated the opportunity to participate in this ESBD model project.
Response:	We saw quite a bit of teacher growth in many of the participants. Teachers felt empowered to finish their units when they left. They felt a real sense of accomplishment. Many days our timing was off so we often wonder if we did not present everything in adequate depth.
Response:	Teachers were very positive by the end, though the first few days were a bit intense. By the end, though, all of the 'survivors' remarked how much they had learned and how valuable the process had been.
Response:	Those that finished the institute had a positive response. I'm not sure what they valued most but I think it was the non-threatening learning atmosphere and the generous amount to time to process the information.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 34. Staff Developers' Description of Teachers for Whom the ESBD Program Is Inappropriate

Response:	No [suitable for all]
Response:	No [suitable for all]
Response:	Teachers who are at the end of their career and not interested in making significant changes in their teaching strategies.
Response:	Teachers with very weak content and/or rigid pedagogies would likely not find this productive.
Response:	Those that are not open to change or do not see teaching as more than just a job.
Response:	Unfortunately there are teachers who don't want to change. They feel what they are doing is just fine, and don't want to think about how to do things better. I did not invite any of those to participate.
Response:	We had a wide range of teachers in the program, and they all seemed to benefit from it. We even had a school counselor who teaches hot-air ballooning and is very interested in science, and she benefited from the course.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Staff developers' responses to whether the ESBD program had met their professional development goals were very positive (Table 35), with one noting that he or she will use backward design in all professional development classes. Staff developers were also in agreement that the ESBD program is focused primarily on pedagogy (Table 36).

Table 35. Staff Developers' Comments about ESBD Program as Meeting Professional Development Goals

Response:	I believe I need to see the total year before I can adequately rate teacher's growth. At the moment, both the science supervisor and I both believe that these teachers know more about UbD than any other teacher in the district.
Response:	I think the program addressed our major goals most efficiently.
Response:	I wanted our teachers and me to become more familiar with the understanding by design process so that we could look critically at our middle school curriculum and strengthen it. I think the summer institute was very useful in that respect. We will continue to use backward design for all our professional development classes this school year. We will use it to align our curriculum with the new state standard just approved last May.
Response:	It supported our continuous PD efforts and the PD goals of the school districts we service.
Response:	The program was very effective in further developing our institutional commitment to UbD-based approaches to professional development.
Response:	They were very effective and I feel everyone attending left with a positive feeling and a much broader knowledge base.
Response:	With the few additions we made, the program was effective at addressing our PD goals.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 36. Staff Developers' Comments about ESBD Program Curriculum: Pedagogy or Content

Response:	ESBD was more pedagogy-oriented because more time was spent on UbD than on Earth science content.
Response:	I think it is more pedagogy-oriented because it is a tool and framework for thinking about what students must know. If teachers do not have an adequate content background, the process is very difficult unless they get guidance on what the big ideas are. Once they have the big ideas, there may be an increase in content understanding as they look for materials to use with their units.
Response:	I view ESBD as more of a pedagogically oriented project. I know the teachers would have liked it to have been more content oriented. It may be beyond the goals of what is to be accomplished, but the incorporation of more Earth science content would be beneficial to most middle school teachers who generally have a weak background in the Earth sciences.
Response:	It is a blend. One is driven by the other which makes it a perfect teaching tool. Work done in isolation rarely transfers.
Response:	Mostly pedagogy, though based in a strong content framework. It just doesn't provide the essentials of the content base.
Response:	Primarily pedagogy-oriented, although the visualizations helped with the content. The first week's work on rock cycle could have been content-rich except that most of the teachers in our workshop don't teach rock cycle and weren't interested in going into depth on it.
Response:	We viewed it more as pedagogy than content.

Open-Ended Responses
Field Test: N = 7
Missing: 0

The results described in this section indicated a high level of satisfaction with the ESBD program for these staff developers.

Aspects of Field Test Sites' Implementation of ESBD

This section reports staff developer responses to questions about the support they had provided and planned to provide to teachers at the time of survey completion (see Appendix C).

Post-Institute Support to Teachers

Most of the staff developers (5) had contact with teachers following the summer institute (Table 37) and planned to continue contact with them during the school year (Table 38). The most frequent mode of contact staff developers expected to use with teachers was email (Table 39). All but one of the staff developers (6) expected to meet with teachers in person at least once during the school year, suggesting a high level of commitment to supporting teachers as they implemented their units.

Table 37. Staff Developers' Reports of Post-Institute Teacher Contact

Frequency	
No	Yes
2	5

Mean and Frequencies
Field Test: N = 7
Missing: 0

Table 38. Staff Developers' Reports of Plans to Contact Teachers

Response:	All staff will do this. We're not sure about frequency yet.
Response:	Teachers will work with their partners and staff will be available via email.
Response:	Three of the staff and I will be available to help with the fall conference. It will be held soon. I have contacted all staff and teachers and reminded them to start looking again at the units. The staff members are assigned to specific teachers and they will be looking at the units before they meet.
Response:	The two primary staff members are presently reviewing the units. We are providing feedback to the teachers.
Response:	Two consultants will be available to conduct the post-institute sessions scheduled during the school year.
Response:	We all met at the science in-service day prior to school starting. I do communicate with them via email and address their needs.
Response:	We provided daily feedback as the units evolved; we will make 1-2 contacts per teacher prior to the fall conference.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 39. Staff Developers' Reports of Mode of Post-Institute Communication

	Mean	Frequency			
		Not at all	In response to requests	1-3 times each	More than 3 times each
Email	4.00	0	0	0	7
Telephone	2.57	0	4	2	1
In person	3.29	0	0	4	2

Mean and Frequencies
Field Test: N = 7
Missing: 0

Only one staff developer had scheduled classroom observations at the time of survey completion, but the rest expected to observe their teachers (Table 40). In terms of teachers' conducting peer observation, staff developers indicated that the teachers would make those arrangements (Table 41). Two of the developers noted that they would be supporting peer observation with funds for substitute teachers.

Table 40. Staff Developers' Comments about Plans for Staff Developer Observation

Response:	I have made appointments to discuss their units and observe their students. I also plan to return during their implementation.
Response:	I plan to visit each classroom at least once while they do their units.
Response:	I will observe the lessons as time and my schedule permit. I have no dates set up at this time.
Response:	Staff will schedule classroom observations after the fall workshops.
Response:	This will be worked out between staff and participants as the new school year begins.
Response:	We plan on visiting each teacher.
Response:	We will visit the classrooms to see the units in action at least a couple of times per teacher, if at all possible.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table 41. Staff Developers' Comments about Plans for Peer Observation

Response:	As above: [I have made appointments to discuss their units and observe their students. I also plan to return during their implementation].
Response:	Each teacher plans to be observed by their partners at least once. Some may do videos of lessons.
Response:	I have had teachers begin to make appointments with each other. They know how to access the sub funds and know about the observation tool. We shall see what happens.
Response:	Participants will schedule their peer observations based upon their own teaching and district schedules.
Response:	Teachers have been encouraged to do this; we will provide substitute pay if needed.
Response:	Teachers working at the same school will be able to observe each other's classes. Between school visits may be more difficult to schedule, but I will try to see if they can be done.
Response:	The teachers are working on an observation schedule now.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Three of the comments in Table 42 show that staff developers valued their experiences with ESBD. Two developers advocated using the approach more widely.

Table 42. Additional Comments from Staff Developers

Response:	I think with some minor modifications, the format for the ESBD institute is valuable for all middle school science teachers and pre-service teachers as well.
Response:	It was difficult being the first site because not everything was developed as far ahead as I would have liked. It all worked out fine, but I would have been more comfortable with a little more lead time. The problems with getting approval from my district were very worrying. I actually lost sleep over it.
Response:	None.
Response:	None, but [Science Supervisor] would like to know if you have any plans to expand this into other content areas?
Response:	This has been a very comprehensive follow-up survey. We greatly appreciated being involved in this ESBD project

Open-Ended Responses
Field Test: N = 7
Missing: 2

Field Test Teachers' Experiences and Evaluations

Beyond comparing the field test group with the TERC group, it is also important to understand details of the field test group's experience in implementing ESBD, because this group received the scaled-up implementation of the ESBD model.

Field Test Teachers' Evaluation of ESBD Resources

In addition to the results reported above, field test teachers were asked to evaluate the resource materials that are part of the ESBD program. Field test teachers responded to additional questionnaire items that asked them to rate the ESBD Web site and the ESBD unit planner. Regarding the ESBD Web site (Table 44), only five teachers (8%) reported that they did not use it. Almost three-quarters of teachers (69%) rated their use of the Web site as useful or very useful, and only one teacher reported that the site was not useful. Table 45 shows that field test teachers rated the online unit planner very highly.

Table 44. Field Test Teachers' Ratings of Usefulness of ESBD Web Site

	Mean	Frequency
I did not use it	3.89	5
Not useful		1
Somewhat useful		11
Useful		20
Very useful		22

Mean and Frequencies
Field Test: N = 61
Missing: 2

Table 45. Field Test Teachers' Ratings of Experience with Online Unit Planner

	Mean rating
The unit planner was easy for me to access.	3.6
The unit planner was easy for me to use.	3.3
The unit planner helped me to design my unit.	3.5

Scale: Strongly disagree, Disagree somewhat, Agree somewhat, Agree strongly

Mean
Field Test: N = 61
Missing: 15

Field Test Teachers' Ratings of ESBD Approach

Field test teachers were also asked to rate their mastery of specific Understanding by Design ESBD instructional strategies and broader ESBD practices. Mean ratings are presented in Tables 46 and 47. The field test group was asked the two questions reported in Tables 46 and 47 both after the summer institute and after unit implementation (see Tables 3 and 4). Ratings were very similar at both points in time, meaning that teachers accurately assessed what they had learned at the institutes that would make unit implementation successful. The alternative scenario would have been that implementation did not go well, causing teachers to rate their skills enhancement and preparedness less favorably than they did.

Table 46. Field Test Teachers' Ratings of Skills Enhancement after Unit Implementation

	Mean rating
Inform students at the beginning of the unit or course	3.5
Hook and hold students' interest	3.4
Use a variety of strategies to promote understanding	3.4
Facilitate students' active construction of meaning	3.2
Promote opportunities for students to 'reveal their thinking'	3.2
Use questioning, probing, and feedback	3.2
Teach in the context of big ideas and explore essential questions	3.4
Use information from ongoing assessments to adjust instruction	3.1
Use information from ongoing assessments to check student understanding	3.2
Use a variety of resources to promote understanding	3.6

Scale: Not effective, Somewhat effective, Effective, Very effective
Field Test: N = 61
Missing: 6

Table 47. Field Test Teachers' Ratings of Preparedness after Unit Implementation

	Mean rating
Teach the 'big ideas' in Earth science	3.3
Use visualizations in teaching Earth science	3.4
Design learning experiences that address the big ideas	3.3
Design units according to the UbD principles and procedures	3.4
Design assessments to assess understanding	2.9
Design and apply rubrics for evaluating student work or performances	2.9
Use performance assessments	3.1
Analyze, evaluate, and provide feedback on the learning designs of peers	3.1
Discern and formulate topics 'worthy of understanding'	3.3
Use the WHERE framework to design instruction	3.2
Design curricula that addresses students' misconceptions	3.1
Design assessments to detect students' misconceptions	3.1
Use the notion of 'understanding' to guide instruction	3.2

Scale: Not prepared, Somewhat prepared, Prepared, Very prepared
Field Test: N = 61
Missing: 6

Contextual Aspects of Field Test Teachers' Participation

Tables 48 and 49 present data regarding contextual aspects of field test teachers' participation in ESBD. Fewer than a third (29%) of field test teachers were provided release days or other forms of support from their districts (Table 48). However, field test teachers reported that their districts had either sufficiently or more than sufficiently provided curricular resources for implementation of their ESBD units (Table 49). Almost half of field test teachers (41%) were also able to repurpose their existing curricular materials (Table 48).

Table 48. Field Test Teachers' Reports of Other Implementation Factors

	Percent	Count
Teachers whose districts provided release days	29	30
Teachers whose districts provided other forms of support	29	30
Teachers who repurposed existing curricular materials	41	42

Table 49. Field Test Teachers Whose Districts Provided Curricular Resources

	Percent	Count
Not applicable	20	12
None were provided	5	3
Not sufficiently	10	6
Sufficiently	52	32
More than sufficiently	10	6

Details of Field Test Teachers' Experiences and Evaluations

In addition to the ratings presented above, the field test teachers were asked to report, in open-ended text responses, about various aspects of their experiences in the training and implementation of ESBD.

Teachers reported devoting many hours to the planning and preparation of their ESBD units outside the summer institute. Many teachers also noted that the amount of content they covered in an ESBD unit was greater or much greater than the amount of material typically addressed in a unit. The average number of hours reported for preparing the ESBD unit was 39. There was a bimodal distribution in teachers' reported preparation hours, with 30 hours and 40 hours tied for the most frequently reported number of hours. The median reported preparation time was 30 hours. Table 50 summarizes the frequency of hours reported, with 47 teachers reporting.

Table 50. Teachers' Reports of Unit Preparation Hours (after Summer Institute)

Hours	Frequency
5	5
7	1
8	1
15	3
25	6
30	8
40	8
50	4
57	1
60	2
80	5
100	5

N = 47

Field test teachers reported that their ESBD units lasted an average of 33 days, with a mean of 24 days and a mode of 20 days. Table 51 summarizes teachers' reports of the duration of their ESBD units.

Table 51. Reported Duration of ESBD Units

Days	Frequency
4	2
5	1
8	1
10	4
12	1
13	1
14	3
15	2
20	7
21	1
24	1
25	3
28	1
30	2
35	5
41	1
45	6
47	1
50	1
75	3
90	1
180	1

N = 49

The time required for unit planning and the length of the unit were the issues mentioned most frequently by teachers in describing the greatest challenges they faced in implementing their ESBD units (Table 52). Approximately 28% of teachers who responded to this question mentioned that the length of the unit was a challenge. These teachers mentioned the difficulty of fitting their unit into the constraints of local curriculum scope and sequence requirements and the need to make adjustments in their unit in the course of implementing it to fit it into the available time.

About 26% of teachers responding to this question mentioned that planning time was the greatest challenge in implementing their unit. Other teachers (about 24%) mentioned challenges related to use and integration of technology. Several mentioned lack of support from colleagues and materials and the expense of materials as their greatest challenge. A range of other challenges were also mentioned.

Table 52. Greatest Difficulty Faced in Implementing ESBD Unit (N = 42)

Length of unit or activities / Constraints of curriculum (12 mentions)
• The unit was very long, maybe too long. It was the first time I had taught this unit in such length. My own lack of expertise in the subject area did make me feel uncertain about assessment. • I found the greatest challenge was to adjust the unit to fit within new time constraints described above. • Greatest difficulty was time management. I used the unit with a sixth grade mixed abilities class comprised of 36 students. I encourage student engagement through hands on involvement; I had to modify several activities on the fly.

- I pretty much plan my units and implement them. I am the only 8th grade science teacher so I was able to move things around to implement all four of my units.
- District common testing using text. Trying to fit the project in a time frame meant to be used for text book instruction. It seemed like the kids just got interested and we were starting to get in depth and needed more time to cover the (test) material, and we were done. It needed a lot more work.
- Always time is an issue, I created a video that went over the main ideas in the unit that gave the students a starting point for learning about heat. I also did not give enough time to fully do the assessment project with the students.
- Trying to manage a large concept unit such as Astronomy that had not been specified what areas to cover other than in the State standards which are sometimes too specific about some areas and too vague in most others.
- Time. My unit took 2 months to teach. I used the entire 2 months.
- Time, I underestimated the amount of time necessary for my Unit, but took the time anyway.
- Not having enough time. I had to shorten my unit and skip some of the activities.
- The activities I planned would have been ideal if I had a block schedule. It was difficult to do a quick weather forecast and then move on to the day's activity. Most classes seemed to be monopolized by the 'quick' weather forecasts.
- Also, our district required specific vocabulary study, so that had to be added. The unit took much longer that our curriculum allowed. I did it anyway, then found during the course of the unit that next year a good portion of the content will be moved to 8th grade rather than 6th. My district is requiring that all teachers have one UBD unit in place next year, so this one will need to be changed. That is frustrating.

Time (11 mentions)

- Time Management The quarter ended and there was still much to cover. I had to complete the lesson with three of five classes as a student teacher had designed a biology unit to begin right after winter break.
- TIME! Since it is mentioned above
- Time plain and simple, time. I also am learning computers so double whammy
- Finding the appropriate amount of time to implement the plan and creating a classroom that properly allowed for use of web technology.
- Time was a problem. I also had to do 'science projects' at almost the same time that the unit was scheduled. I now want to find a way to combine the two.
- Time constraints.
- Again it is finding the time to prepare for web related activities and frustration with our current computer lab;
- Having the stretch of time to plan so to continue the 'train of thought' particularly when just having met with the trainers.
- time to prepare
- I needed more time.
- Time and support from the classroom teachers were my greatest challenges, and I wasn't very successful with dealing with either challenge.

Technology (10 mentions)

- Not having the net to use with my unit.
- The most challenging aspect was keeping up with implementing the unit, using technology and then trying to reflect. I found it difficult to reflect in writing. During this next unit I plan to reflect more in journal format.
- Technology slowdown!!!! Unsure of myself at times since it was new.

- Time to reflect, hunt down materials, technology failures. Technology slow down and ability to cover material in a timely manner. Lack of student Internet Contracts.
- Feeling confident with the technology-moving from one website to another. Making sure I reflected on paper after each day. The reflections in my head were more developed and thought out and sometimes I would forget to write anything down. This made it much harder to try to remember what to write 2 days after the lesson.
- Time plain and simple, time. I also am learning computers so double whammy
- The biggest problem was computer access, as stated above. I reduced the requirements for the students working in the Mac lab.
- lack of working technology
- Using technology was difficult, but I worked around it by providing hands on activities to implement the lessons.
- Computer time was limited, resorted to many old tried and true class demonstrations.

Lack of support from colleagues (4 mentions)

- The greatest difficulty I faced was being the 'lone wolf' at my school. Although if I needed support the trainers and others in the group were easily available.
- My greatest difficulty was finding a teacher who had the time to allow me to try my lesson. Unfortunately, the lesson was not completed because I did not have my own class. The positive was that in my new job as a curriculum specialist in systems thinking, I was able to infuse ESBD into trainings with teachers...spread the word about looking at curriculum in a different way.
- Time and support from the classroom teachers were my greatest challenges, and I wasn't very successful with dealing with either challenge.
- The main problem I had was that students seemed to work at half the speed I expected, and some students finished much earlier than others. Next time, I will try to assign each part in smaller increments with it being homework to finish each bit. Hopefully, this will keep students together more and not allow some students to feel overwhelmed.

Student-related factors (3 mentions)

- No difficulty in using implementing this unit. I wish that students had taken a more active interest. They did like the initial phase and set up, but as the assessment piece neared, they shut down on me. A real confidence blow!
- Getting students to sustain their level of engagement throughout the whole unit! Keeping it relevant to them.
- The greatest difficulty was overcoming the students' apathy toward science learning in general! They really disliked science when I first met them. They had many misconceptions about science in general and plate tectonics specifically. The best thing I have found to engage them is to go to the internet and get on an interactive site like www.scotes.com and let them play around in there for awhile. Then we talk. Play first, talk later.

Materials, expenses (3 mentions)

- I borrow a Science classroom one hour per day. It was extremely difficult to gather materials and to set up labs as well as cleaning up afterwards.
- I had to purchase the majority of supplies for the GRASPS project—expensive!
- I will mention the second greatest difficulty I faced in implementing my ESBD unit. MONEY! I think the strategy to face this, is to tell new participants to the program, if it is refunded, is to save their stipend as an implementation source of funds. I found myself running to the thrift store, Dollar Store, K-Mart, Target, Wal-Mart, etc. trying to locate the least expensive but essential materials needed to implement my unit. Money also needs to be set aside for putting together the implementation report and the conference presentation in either of its suggested formats.

Other issues (6 mentions)
• While teaching the unit, I no longer thought my assessment was good. I didn't want to change the assessment since the unit was based around it, but I didn't like it. • I am no longer school based. • This wasn't with the implementation, but with the performance assessment. I was very disappointed with the results and will adjust my lessons next year accordingly. • During the implementation of the unit, our school district experienced 10 1/2 days of interruptions due to snow days, inservice, holidays, etc. This interrupted the flow of the unit. I found that I had to continually change the planned activity to make things fit together correctly and to the greatest advantage of the students. • Working out the day to day. Did I cover too much or too little? I have run class one way and it took some adjustment doing things differently. • I had trouble getting the unit taught before I had my Baby. 12/9/04. I thought I would have more time because I was not due until 12/19/04.

Fifty-five teachers provided information about how technology was used in their ESBD units (although 3 of these respondents stated that they did not use technology). The most frequently mentioned (by 51% of respondents to this question) use of technology was students' use of the Internet during classes. Specific uses of the Internet mentioned included students' research on specific topics, accessing the Internet during class to do activities available on Web sites, and use of resources from specific Web sites as instructional resources or references during class time. Another 29% of teachers mentioned use of the computer-based visualizations and/or animations as their specific use of technology. Some of these teachers mentioned using the visualizations that they were introduced to at the ESBD summer institute. Five teachers' descriptions focused on use of technology by the teacher during instruction as an instructional resource (e.g., displaying Web-based images or information to the class with an overhead projector).

Table 53. Descriptions of Technology Use in ESBD Units and Difficulties Encountered (N = 55)

Internet use by students: searches, use of Web sites for research or in-class activities (28 mentions)
• We needed to use our Tech Lab for many interactive websites that we chose to use. We also needed access to LCD projectors for visualizations and for student presentations. Some difficulties we had was the difficulty with our school's internet and how slow it was in downloading various sites. It was also a problem at times when the internet was down or the site had changed. Alternate plans needed to be ready. • Well when you do have computers and they are hooked up to internet, as I do luckily, you sure better have a back up plan because if things are going to go wrong they will the day you have a class lesson planned involving the internet. I did have sites on worksheets with questions to assist them in getting through the material. Or something that was relevant to the lesson. They have a road map to follow. I have found that sometimes the web site was not available anymore. Bummer. I also asked the students to surf the web for other sites that might be relevant to what we were working on. They rally came through and we listed ones that were good for others to use. I also saved them for future use. I did get installed something that allowed for my computer screen to show up on the TV in the classroom. That was a bonus because the principal saw that I would use it. • Satellite pics, internet search, use S'COOL website Managing time was the only difficulty.

- I used technology for a reference tool for students to read and see content on clouds, the water cycle, etc. in a different way (other than a book or article). We explored satellite images on the internet to see what meteorologists use to view weather systems, etc. and to write down web sites they might go back to for use in their GRASP assessment.
- Research Microsoft Word
- Having the technology available is necessary to use the web sites.
- Students researched constellations and myths behind constellations on line. Visualizations were used for finding constellation and understanding its movement through the sky during the year. Most important difficulty was getting time on computers when I needed it. I'm still hearing about how I've hogged the computer lab this year (11 days total in 3 quarters). One day we were trying to use the computers, the whole internet was down for 1 1/2 periods. This does make it difficult to stay on schedule.
- A mobile laptop lab and my classroom computers were needed for students to access a web site I developed on the geology of New Hampshire. Students need to access this site to get needed information to construct a geology safari brochure to be taken in NH. The internet is also needed for additional geologic and tourist resources. Built into this brochure is an explanation of the geological significance of each site that gets visited in the state. Difficulties encountered: the need to share the mobile laptop lab with the rest of the school. Not a major problem, you just need to sign up in advance for more time than you think will be necessary.
- I used the websites suggested by ESBD. I was able to preview sites for appropriate level. I also set up a website for my students. This enables me to have parents and students preview my units. Also, previewing the sites has cut way down on students spending too much time looking for appropriate sites.
- Websites for activities and to use during lessons. Also for students to use in developing their Stage 2 assessment.
- Students used websites to get current and past volcanic and earthquake data, weathering, erosion and climate data
- My students used the internet for email notifications of earthquakes that were then plotted on a world map. We used the internet to view a Brainpop film and to take a quiz on earthquakes. The students also used the internet to view SciLinks and for research for their final presentation which included a Power Point presentation.
- It allowed students to do research. I used the computer to access the national and state benchmarks and more easily correlate them to my projects. The computer allowed me to interface with other educators and more fully develop strategies that enhanced multi learning strategies.
- I used 2 short videos to show kids how a space suit works, and how people live, sleep, and work in space. I used numerous website activities to simulate missions in a space station, to learn about how the electromagnetic spectrum works, to understand infrared radiation, and to learn about space junk and product spinoffs. Difficulties that I ran into were mainly that the red bulb in my computer projector went out, so all the colors were off. We used averkey and displayed it on the TV instead. The program I was using to finish up my webquest was removed along with a computer in my room, and I had difficulty getting it reloaded on the new computer. My last problem was in checking out the computer lab, I couldn't get all my classes in there. I improvised by playing the games, simulations, and activities as a whole class and it was actually great. The kids worked together to solve the problems and were totally on task.
- The students used technology as an implementation during my lesson by being engaged in research with the Jason Project. Also the students created web-pages and powerpoints to entice the general public to visit their wetlands. They found details and visual aids to help them understand the natural formation of the river systems. They had used probes to measure temperature and created graphs form the excel program.

- Access to the web allowed students to see seismic data and video clips of timely news stories. Difficulties???? How about a school wide power failure. That made technology rather difficult that day. Then there was the day that the web couldn't be accessed AT ALL from my classroom. Then there is the district FIREWALL that stopped a lot of access to video clips. OK, and some students couldn't use the internet for research because their parents haven't signed the permission slip. Or maybe, the form was never filed by the powers that be.
- utilized several websites and had to do this with a projector. I already had access to this. I also used a few sites as webquests/seatwork. This is not as easy with 4 classroom computers, but we managed. The main problems were not curriculum; they were technological: ID User numbers not entered, students never having internet permission forms turned in, being offline, etc.
- Technology added to the realistic scenario by providing real places/people/activities in real time.
- I believe that when the students were able to view interactive sites that showed plate movement, folding/faulting, structure of the Earth, etc. they became engaged for the first time with the idea of a dynamic geosphere. My guess is that for skeptical adolescents 'seeing is believing', at least in the beginning of a new topic. Telling students and showing them pictures in books and even viewing videos or DVDs did not have anywhere near the impact that viewing interactive and non-interactive but visually vivid websites did. Sites used include: http://www.scotese.com/; http://maritime.haifa.ac.il/departm/lessons/ocean/lect06.ht; http://library.thinkquest.org/17457/platetectonics/4.php;http://www.pbs.org/wgbh/aso/tryit/tectonics/#. These sites worked well for my students. There are, fortunately, for us in this day of instant internet availability, many more good sites.
- I did an astronomy unit. Because our books are dinosaurs, we found newer info on the internet.
- Visuals were used to demonstrate abstract ideas. Internet resources were vital to locating information for student project completion. The computer provided multisensory experiences and heightened student interest/participation. As a teacher, it provided me with invaluable ideas and resources for teaching my material. Students utilized technology for presentation of their material and as a culminating activity to demonstrate knowledge.
- We were able to use many of the resources that we found during the program last summer. They were very well received by the students.
- Students used technology to explore different sites about the topic of Reduce, Reuse and Recycle.
- My students used the internet for research. We also used the school's video camera and digital camera to record our work. Also, technology was used by me to find visualizations and web quests
- We used the technology to gather information on the ocean floor and water movement via the internet and we also used software provided through the summer institute to image the ocean floor. The only problems encountered were ones typical to any computer usage and were not ones that interfered to any large extent.
- My students used the weather channel to track storms and daily weather. I had planned on having students access the internet to view weather sites. My plan was to project the sites for a class discussion. My grant proposal for a class projector was denied. Fortunately, I received a different grant for a projector. Unfortunately, I didn't receive the projector until months after my meteorology unit was completed. This will definitely enhance the unit for next year.

- Students were able to explore websites for the Hook to study more about space (sun, moon and Earth relationship). However, we only had use of the computer lab for 2 days. Classroom technology was limited to one desk computer that was not hooked to an LCD projector (technology that is new to our school and my familiarity was only when used at Plymouth). My students would have liked to use the computer to explore more or view links that show daily changes in the sun view by telescopes from Earth and orbiting in space. Many students did have access to computers at home but then activities would have been self taught (?) and not as productive.
- Students did much research on the internet with teacher provided websites. Many students chose their performance based projects to be in the power point format.

Animations and visualizations (16 mentions)

- Technology is vital to using this model to its most effective level. Animations and visualizations help students get the big ideas. Any way that the Internet can be developed into these units is better than no Internet. The Internet has a wealth of information that students can access to show them how much is out there.
- We were able to click on our hyperlinks for the visualizations and use a multimedia projector to display them on the big screen. This required advanced notice to the media center as well as some set up time and room rearrangement.
- The visualizations and virtual labs that I used very very beneficial to achieve a deeper understanding for the student. See Reflection Day 1. A major difficulty I had was having the technology continue to fail. Our district is strapped for money and they have downsized our internet making it near impossible some days to change websites in less than an hour. Also, at times the page could not be displayed for whatever reason.
- Visualizations from the web. Student use of technology during presentations and for research. Difficulties surrounded the age of the building and the available resources.
- Satellite pics, internet search, use S'COOL website Managing time was the only difficulty.
- Living in the desert, most students have never seen the ocean.... high & low tides. Technology was very important in order to provide students with background information. The use of visuals was very important for students to be able to understand the interdependence of the sun, moon and earth.
- Students created a Power Point slide show on a river of their choice using images from the internet. They were required to incorporate the major concepts from the unit. Students possessed a wide variety of computer skills.
- I think it is important, but I was disappointed in my ability to find representations in Astronomy and demonstrating locations and distances between objects in the universe
- Technology, i.e. the computer and Internet, was used to locate visualization resources. It was also used to locate information to clear up misconceptions as they came up in the classroom. Our school's computer lab would have been used by the students as a research source in the production of the GRASPS Performance Assessment project in any of its chosen forms—Power Point slide show, story book, or graphic organizer; we haven't reached that point in our unit yet. Common difficulties at our school deal with the ability to schedule lab time successfully for all class periods on days needed for an activity. The availability is built around the three-computer technology teachers' plan periods.
- They were able to look at different pictures that were interactive. Test were taken on the computer, research was done on the computer.
- We viewed animated wave simulations and did an online Ocean Treasure Hunt.
- I used it as a visual aid to my unit
- I used websites to give students visuals of the planets, moon phases, biospheres and many more things. We both used it for research and the student used it for their performance assessment. They gathered information and pictures and many did PowerPoint. The only problem we had was not enough computers in the classroom, which is minor.

- Technology is important for the students to interact with web animations and websites providing further questioning and discovery. The performance assessment for my unit is a creation of a web page by the students, informing other students about earth science understandings. Our computer lab is constantly experiencing difficulties and doesn't have the capabilities to perform some of the web programs. We don't have Smartboard technology, which would really enable us to carry on more class interactions while on the web.
- In this unit I used a Smart Board to show visualizations, post lunar calendars, model research, and expose them to available resources. I have transparencies that I have been able to scan and install on my computer so I can use them on the Smart Board. The Smart Board enables me to store many images, multiple page texts, and visualizations. I use this technology every day. The unit could be taught without technology, but it wouldn't be as stimulating for the students.
- I used a website that had animations and visualizations of the process of erosion. I developed a worksheet with questions related to each of the visualizations. Now that we have United Streaming, I will add that to my lesson presentations.

Internet use by teacher during instruction (5 mentions)

- I used the media cart in my classroom to project things that I wanted the students to see as a class during classroom discussions, I used the media cart hooked up to the Internet to show students useful information during classroom discussions. The original plan was that students would be given assignments to do in the tech lab. This fell through do to a lack of signed Internet Contracts. It is still the intention of the unit that this occurs. Students were also given web sites that they could investigate at home. Riverside program was used in the computer lab.
- It is very hard to take all of my students to have use of a computer in the lab, therefore my unit was designed with less technology. I did however show some clips from the Internet or used overhead pictures. I really did not encounter any difficulties.
- I had never used technology in my classroom (internet) until ESBD. I used internet sites to make the concepts real to my students. After I saw the success of the first few lessons that incorporated technology, I then found lots more sites to use. An example would be the National Geographic site 'Forces of Nature'. After using the power point portion as a mini lesson, I then used the portion where the variables are manipulated to make a building fall. The only difficulties encountered were when the web was down.
- Reviewed web sites on large screen TV with information on heat during lecture. Added pictures and graphics from web sites into a movie created to go with the unit.
- It was used for a visual/hook- a power point pictures taken of kids on digital camera and then a power point made. Use of United Streaming for visuals (our school uses this site). Use of the LCD projector, the internet access and laptop. Some frustration with getting internet access from my room to the portable laptop and also sharing use of LC|D projector.

Other (3 mentions)

- Students used PASCO probes to record temperatures and used software to observe and explain changes over time. No difficulties encountered.
- I used technology at the start of my unit to give my students a pre test. It was in the form of a PowerPoint and the students answered questions after studying the pictures. The difficulty I had in this was asking the right questions. I used words that some students had never heard and many were lost on how to answer them. I had to explain a lot of the questions. I corrected the PowerPoint after I used it with my class.
- Technology was a key piece to our unit. It took the abstract and made it real life for the students. One difficulty encountered was failing technology and having to have backup plans. Another difficulty was the varying ability of the students with technology.

Did not use technology or only minimal use (3 mentions)

- I could not access the computer lab as much as I wanted to. Some activities could have been more effective with the use of computer.

- I did not have internet in my room until after I completed my unit.
- Well, it would have been great to have had use to technology at the time of my unit. I think it would have made a huge impact and difference. I had planned to use the averKey to show students images from the internet to help them with the idea of the rotation/revolution process and see the seasons throughout the globe at different times of year. However, I did not have use in my classroom and therefore could not use it. In the future I will figure out other methods to make sure I am able to use the technology, especially internet sources I found, during my unit and other units for that matter.

Field test teachers were asked to describe areas in which they felt they should have received more time or attention during the summer institute and the fall mini-conference. Forty-seven teachers responded to this question (Table 54). Just over 20% of teachers mentioned assessment, with most of these mentioning performance assessments specifically. A similar proportion of teachers mentioned rubrics as an area of need. About 20% mentioned various specific Understanding by Design topics as areas that should have received more emphasis. About eight teachers (17%) stated they thought all topics received adequate attention.

Table 54. Areas Where Teachers Reported Needing More Preparation (N = 47)

Needed more preparation in specific UBD topics (11 mentions)
• More time for reflective feedback from colleagues. • Systems thinking. • Perhaps more time could have been spent on misconceptions • Stage 3! • all areas needed more time. • Checking for misconceptions. I had a difficult time in doing this. • One of the greatest concerns that may be addressed later is the format on the website for writing the where. No one really had any info on the exact style of the daily lessons. It would have been much easier if there was a template. I also reposted my unit as implemented with the changes that I made during the course of the unit. No one was clear if I needed to do that. • use of computer technology • I felt rushed during the two week workshop we had in June. I wish we had some more time to talk with the other teachers and bounce ideas off of them and get feedback. • Stage Three • Formulating enduring understandings.
Assessment (10 mentions)
• Performance assessments feedback from peers formulating topics 'worthy of understanding' • Because I did not get to implement my whole unit, I'm sure there are things I have not thought through. However, I feel the area of assessment could use more time. I thought there was plenty of time and examples on performance assessment but developing other types of assessment, designing rubrics... good rubrics... and evaluating/ providing feedback to peers could stand to be developed more. • Designing appropriate and manageable performance assessments • It is really my own areas of weakness that I need to address in designing assessments and increasing my understanding of the 'big ideas' in Earth science. • The areas that I felt the weakest in are writing EUs and designing assessment. • Actually designing assessments and rubrics.

- More time for assessment projects. GRASP with its rubric. Sometimes when working in groups with teachers from districts that have more technology readily available, due to time constraints usually they tend do the major computer work (I felt I needed the hands-on but didn't really know what to do)
- Perhaps the assessment part, but like any new practice- using it is the best teacher.
- I need more time to work on the assessment piece. I need to know where to redirect the learning or approach to learning so that more students understand the big ideas and concepts.
- performance assessments time management

Rubrics (9 mentions)

- Rubrics, but I am fairly new to using them. My comfort level greatly increased but I have yet to keep one as it was when I first made it.
- Rubric development and I still don't understand the purpose of the facets cube.
- Rubric development is not hit as much as it could be. Facets could be talked about more. I didn't really like the way they were implemented, it was a bit hard to understand.
- Formulating rubrics. This is a difficult task to make rubrics that truly meet your objectives that the students can understand and that are useful to the teacher in grading.
- I think more time is needed in using/writing rubrics and assessments other than the GRASPS.
- I think more time needs to be spent on designing effective rubrics.
- I think we need to look at rubrics that can be designed in a realistic amount of time, that students will find easy to read and understand what is required of them, and that are concise and to the point. Most rubrics that I have seen in the pedagogical setting are unrealistic and teachers still seem to have a hard time developing them. These comments are really from my general experience, but perhaps ESBD could help us more with this issue. I would also like more time to develop more assessments that assess understanding than I have now for this unit. What we did was good and very helpful, but I needed more time for this. I think the course might have to be three or four weeks long or have a component that we could do at home and log our hours or something of that nature.
- Rubrics
- Designing the rubrics

No areas needed more time (8 mentions)

- You probably can't prepare us for the political side of science instruction—both nationally and locally—since it is different for each location. Otherwise, I think the program is well structured.
- It was good
- None
- I was very content with the ESBD Program because it allowed (forced) me to give more thought to what I was teaching, how I was teaching and how to assess the outcome.
- can't think of one.
- Not sure. I think it was all covered very well.
- I cannot think of any at the moment.
- I think it was all given the time needed. I would love to see a follow up course to continue developing our implementation in all areas.

Other needs (8 mentions)

- working within the limits of our specific school systems and the curriculum therein.
- For me more time and emphasis was on my personal knowledge, but I do not think that had anything to do with the ESBD Program. The program provided adequate emphasis on all parts.

- Just overall, more time could have been used but on the other hand, I can't spend too much time on one topic either.
- The design of the curriculum to handle misconceptions and using understanding better in instruction.
- Designing the unit was VERY overwhelming.
- I think it would be very helpful to have more focus on the activities and how they support the program would have been very helpful to me.
- knowledge of subject matter so I get the big picture more practice of creating units and feedback
- I'm not sure this is something that can be done at the workshops, but after teaching the unit, I see a lot of things that I need to emphasize next year, things that I thought the kids would grasp that they didn't.

Field test teachers perceived their ESBD units to be very effective, overall, in promoting student learning, compared with the way they previously covered the same content (Table 55). Forty-three teachers provided specific reasons for their ratings. Among the 18 teachers who provided explanations for rating their ESBD units as "much more effective" (a rating of 4 out of 4), many respondents stated that they saw evidence of greater or deeper student learning or greater student engagement. Other respondents stated that the nature of the learning activities and the curriculum design were better, mentioning features such as students "knowing where they were going," the opportunity for rich conversations and constructing discursive explanations, and more opportunities for making connections among concepts and ideas. Explanations provided by the five teachers who reported that their ESBD units were only moderately more effective included that they had already been using some Understanding by Design strategies and that they did not use the UbD strategies very effectively yet.

Table 55. Explanations of Ratings of the Effectiveness of ESBD Unit in Promoting Student Learning Compared with Other Ways Same Content Was Covered Previously (N = 43)

Much more effective: Explanations of rating (18 reporting)
• This model promoted student learning because it was focused and engaging.
• They did such a huge variety of activities it met many different learning styles. It also helped to stay focused and to constantly revisit misconceptions. They were excited about learning because of the technology incorporated.
• Students in informal discussions and in the presentation of their GRASP showed a deeper understanding of the concepts than in previous teachings of the same benchmarks.
• The students knew where they were headed. The assessment piece was in place which made planning activities much easier.
• I saw higher level work being produced.
• I think the curriculum delivery is much smoother, less disjointed, following the ESBD method of planning. Keeping the enduring understandings as a focus for the teacher and the student, all involved have a primary focus on, I want to say the 5W's. I'm not sure if that's the correct way to phrase it. But we all knew why we were studying what we were studying and where we were headed—our goal!
• With essential questions posted in the room, and discussions centering on those questions, students were able to focus on the big ideas and enduring understandings. This I had never done before. Students do approach these thoughtfully.
• As I basically stated before, the students asked questions, made connections and seemed to have a better working knowledge of the materials than students in years past and this is the first year I taught 3 classes of lower level students

- Because of the pre/post assessment quiz, I have concrete evidence of student learning.
- I just feel that I was able to hook the students and keep them hooked through out the unit. I think next year, when I will be able to use the net, the unit will be even better.
- I felt that by the discussions we had in class and the assessments the children did that their understandings were better than previous years.
- Students were able to explain the big idea concepts to a greater degree of accuracy and to answer Socratic type questions more fluently.
- More student ownership ....more student interaction
- They did much better on their test on this unit than on other units. Their presentations of the project revealed understanding and acceptance of the big ideas.
- As stated, they had to produce materials to demonstrate their learning.
- Students were accurately answering questions and accurately completing performance assessments
- Students were more engaged in the learning by doing something different each day. Keeping journals was not their favorite thing, but when we discussed their findings or observations all were animated and engaged in the lesson.
- The post tests were given with no 'study time'. They were presentations to science museum staff, community members, Dartmouth college professors etc. These real presentations and post assessments showed real understanding and an effort that was not there before because the audience was different.

More effective: Explanations of ratings (20 reporting)

- It's a new way of learning. Misconceptions were not part of usual lesson development. It's just a new way to teach new lessons that have value.
- I feel that the ESBD unit was more focused on exactly what I wanted the students to know. There was more of a focus on content versus covering the chapter in the past.
- I have used inquiry thinking and many hands on activities in my classroom for the last 3 years. This UbD have added a new flavor to what I have already achieved and helped to better 'convict' my students of what they know
- I found some do not let go of misconceptions easily. There is also the lazy factor of some students
- There were many more discussions about the topic that were not provoked by the teacher.
- Helped me to separate the important from not so important understandings. Helped me to plan ahead for the end result. Helped students to remain focused on the end result.
- It made it more enjoyable to teach the lesson. It was fun doing it by the ESBD way.
- Students did well on their final presentation without additional guidance from me. Usual assessment at the end of the chapter is a test with a review sheet given before the test.
- unknown
- I have been using an inquiry approach, but I think I concentrated more on tracking their understanding of concepts throughout the unit.
- Again, I was not as scattered with my teaching. Before, if a kid asked a good question, for example, I would just go and explain it (if I could) and we would get off track. If this question didn't get asked in the other classes, I might not even address it. Now, when something 'off topic' comes up, I know when they ask it if we will be going over that. And I can choose to address it then or to let them know that it will come up when we do 'blank activity.' I have an agenda that is more effectively planned out and links together in a cohesive manner. Again, we know where we're going!!!
- I think it mostly helped me to stay focused and therefore the students were able to effectively learn what really needed to be learned vs. a little about a variety of aspects within the topic.
- I did a better job of setting up the unit which in turn carried on to the other lessons.

• I am a new teacher and I have never taught the hydrosphere before. I did attend a 3 day workshop last summer to help me prepare for the following school year on the environment and the earth's water. With the insight and methods that they used I adapted many of them into the ESBD way and therefore I think with both methods I was ready to be more effective. • I found students using the vocabulary and discussing current events and causes more often. • They were interested in the topic and participated. • because this process allows me to look closely at what I am doing or going to do! • Students seemed to make more connections to the previous activities. Usually students don't seem to be able to see the big pictures. (They just regurgitated facts back to me.) • Seeing the Big Picture More actively engaged • Participation by 'problem students', note, not all, there was one student that never did become engaged.
Moderately more effective (5 reporting)
• Again, the UBD is how I have planned my units in the past so the ESBD unit wasn't much different. • I think I already used many of the steps in UBD before the class. • From the previous time I taught this unit the students did have a better understanding of the concepts, I just did not get the engagement. • I felt the students have more understanding. • Next year, I expect it will be Much More Effective because of changes that I am making. I did like finding out what their misconceptions were at the start of the unit. In the past, I hadn't taken them into consideration.
Not as effective
(One person gave this rating but provided no explanation.)

Peer observation by teachers is a key element of the UbD training provided through the ESBD program. Field test teachers were asked to rate, on a four-point scale, how prepared they felt to do peer observation and to provide an explanation for that rating. There were 20 substantive explanations provided (Table 56), not including 9 respondents who reported not doing an observation. Teachers who rated themselves as prepared or very well prepared for peer observation attributed their preparedness primarily to the quality of the ESBD training or materials or to prior experience with peer observation. Some teachers who rated themselves as only moderately prepared or not well prepared to participate in peer observation explained that they lacked time to prepare or adequately provide feedback. Others reported logistical difficulties.

Table 56. Peer Observations: Explanations for Ratings (N = 20)

Prepared or very well prepared (10 reporting)
Quality of Materials and Training • Outstanding training! • The manual had adequate guidelines to use for this. • Lots of templates and examples were provided. *Other Factors* • As a clinical education teacher, I have been previously trained to doing a running commentary for beginning teacher observations. I have done several in the past. • each lesson is not a template but varies greatly but I enjoyed the peer collaboration and review.

- I had already completed and implemented by unit.
- We teach in the same building and we are able to share with each other daily. It was very helpful in implementing our units. They were more casual observations, not formal.
- We worked together in class and acted as advisors to one another during the construction of the units.
- I am a mentor to new teachers and have conducted many observations in the past.
- My partner went over the unit with me before I observed and also told me where in the unit they were at.

Not prepared or moderately prepared (10 reporting)

Time

- Time seemed to be slipping away and the last session was just around the corner.
- Not enough time to meet before observation
- I felt I was in the middle of many other district mandated responsibilities that held me up from having everything ready for them to observe adequately, but over all, it was still nice to have another colleague around to observe, and give me feedback.
- No time because of the traveling distance.
- Lack of Experience/Novelty of Activity
- It was just very new for me. It was the first time in four years of teaching that I had ever observed someone else teach.
- I've never done something like that before.

Other Factors

- I had not begun implementation at the time I viewed my partner.
- My knowledge base of Earth History/Geology is very weak in comparison to my partners. I felt competent to observe and give feedback on delivery methods, classroom management strategies, and potential ideas for improvement. When it came to content area, I found myself taking copious notes to use in my own classroom when delivering the same lessons in a short time.
- I was not aware of the report we would have to write after the observation.

Appendix A. TERC Group Institute Evaluation Questionnaire

Survey Questions

Survey Section 1: Institute Content

Question 1. Preparedness after Training

Based on your experiences in the institute, how prepared do you feel to do each of the following? Mark one choice for each item.	
Very unprepared	1
Somewhat prepared	2
Prepared	3
Very well prepared	4

Question 2. Skills Enhancement

How effective was the institute in increasing your ability to do each of the following? Mark one choice for each item.	
Not effective	1
Somewhat effective	2
Effective	3
Very effective	4

Question 3. Barriers to ESBD Unit Implementation

Rate the extent to which each of the following could be a barrier to implementation of an UbD unit during the coming school year. Mark one choice for each potential barrier.	
A major barrier	1
A minor barrier	2
Not a barrier	3

Question 4. Increased Teacher Knowledge

How has participation in this institute affected your teaching knowledge generally? Mark one choice for each item.	
Has not increased	1
Has increased somewhat	2
Has increased	3
Has increased greatly	4

Survey Section 2: Institute Evaluation

Question 5. Institute Process Satisfaction

Rate your level of satisfaction for the following aspects of the institute. Mark one choice for each aspect.	
Not satisfactory	1
Somewhat satisfactory	2
Satisfactory	3
Very satisfactory	4

Question 6. Instructors and Support

Rate the degree to which each of the following factors helped you to achieve the goals of the institute. Mark one choice for each factor.	
Helped Very Little	1
Helped Somewhat	2
Helped	3
Helped Very Much	4

Question 7. ESBD in Comparison with Other Professional Development

Rate aspects of this institute in comparison with similar professional development activities in which you have participated. Mark one choice for each aspect.	
Below average	1
About average	2
Among the best 15%	3
Best of all	4

Question 8. Effectiveness of Teaching and Learning Strategies

How effective overall were each of the following teaching and learning strategies and topics in the institute? Mark one choice for each item.	
Not effective	1
Somewhat effective	2
Effective	3
Very effective	4

Question 9. Relevance of Activities

How relevant was each of the following to the goals of the institute? Mark one choice for each item.	
Not relevant	1
Somewhat relevant	2
Relevant	3
Very relevant	4

Appendix B. Field Test Group Institute Evaluation Questionnaire and Results

Survey Questions

Survey Section 1: Institute Content

Question 1. Preparedness after Training

Based on your experiences in the institute, how prepared do you feel to do each of the following? Mark one choice for each item.	
Very unprepared	1
Somewhat prepared	2
Prepared	3
Very well prepared	4

Question 2. Skills Enhancement

How effective was the institute in increasing your ability to do each of the following? Mark one choice for each item.	
Not effective	1
Somewhat effective	2
Effective	3
Very effective	4

Question 3. Barriers to ESBD Unit Implementation

Rate the extent to which each of the following could be a barrier to implementation of an UbD unit during the coming school year. Mark one choice for each potential barrier.	
A major barrier	1
A minor barrier	2
Not a barrier	3

Survey Section 2: Institute Evaluation

Question 4. Institute Process Satisfaction

Rate your level of satisfaction for the following aspects of the institute. Mark one choice for each aspect.	
Not satisfactory	1
Somewhat satisfactory	2
Satisfactory	3
Very satisfactory	4

Question 5. Instructors and Support

Rate the degree to which each of the following factors helped you to achieve the goals of the institute. Mark one choice for each factor.	
Helped Very Little	1
Helped Somewhat	2
Helped	3
Helped Very Much	4

Question 6. ESBD in Comparison with Other Professional Development

Rate aspects of this institute in comparison with similar professional development activities in which you have participated. Mark one choice for each aspect.	
Below average	1
About average	2
Among the best 15%	3
Best of all	4

Question 7. Effectiveness of Teaching and Learning Strategies

How effective overall were each of the following teaching and learning strategies and topics in the institute? Mark one choice for each item.	
Not effective	1
Somewhat effective	2
Effective	3
Very effective	4

Question 8. Effectiveness of Teaching and Learning Topics

How effective overall were each of the following teaching and learning strategies and topics in the institute? Mark one choice for each item.	
Not effective	1
Somewhat effective	2
Effective	3
Very effective	4

Question 9. Relevance of Activities

How relevant was each of the following to the goals of the institute? Mark one choice for each item.	
Not relevant	1
Somewhat relevant	2
Relevant	3
Very relevant	4

Survey Responses

Survey Section 1: Institute Content

Table B-1. Preparedness after Training

Based on your experiences in the institute, how prepared do you feel to do each of the following? Mark one choice for each item.	Mean	Frequency			
		Very unprepared	Somewhat prepared	Prepared	Very well prepared
Teach the 'big ideas' in Earth science	3.22	1	4	38	20
Use visualizations in teaching Earth science	3.25	1	3	38	21
Design learning experiences that address the big ideas	3.17	1	4	41	17
Design units according to the UbD principles and procedures	3.08	1	6	43	13
Design assessments to assess understanding	3.00	1	8	44	10
Design and apply rubrics for evaluating student work or performances	2.90	1	11	44	7
Use performance assessments	3.21	1	4	39	19
Analyze, evaluate, and provide feedback on the learning designs of peers	2.97	1	9	44	9
Discern and formulate topics 'worthy of understanding'	3.08	1	8	39	15
Use the WHERE framework to design instruction	3.08	0	9	40	14
Design curricula that addresses students' misconceptions	3.10	1	3	48	11
Design assessments to detect students' misconceptions	2.92	1	15	35	12
Use the notion of 'understanding' to guide instruction	3.14	1	5	41	16

Means Rating and Frequencies
Field Test: N = 66
Missing: 3

Table B-2. Skills Enhancement

How effective was the institute in increasing your ability to do each of the following? Mark one choice for each item.	Mean	Frequency			
		Not effective	Somewhat effective	Effective	Very effective
Inform students of the big ideas and essential questions, performance requirements, and evaluative criteria at the beginning of the unit or course	3.37	1	5	27	30
Hook and hold students' interest while they examine and explore big ideas and essential questions	3.32	1	4	32	26
Use a variety of strategies to promote deeper understanding of subject matter	3.33	1	6	27	29
Facilitate students' active construction of Meaning (rather than simply telling)	3.22	1	9	28	25
Promote opportunities for students to 'reveal their thinking'—to explain, interpret, apply, shift perspective, empathize, or self-assess	3.16	1	8	34	20
Use questioning, probing, and feedback to stimulate student reflection and rethinking	3.14	1	9	33	20
Teach basic knowledge and skills in the context of big ideas and explore essential questions	3.35	1	5	28	29
Use information from ongoing assessments as feedback to adjust instruction	3.11	1	9	35	18
Use information from ongoing assessments to check for student understanding and misconceptions along the way	3.21	1	6	35	21
Use a variety of resources (beyond the textbook) to promote understanding	3.56	1	0	25	37

Means Rating and Frequencies
Field Test: N = 66
Missing: 3

Survey Section 2: Institute Evaluation

Table B-3. Barriers to ESBD Unit Implementation

Rate the extent to which each of the following could be a barrier to implementation of an UbD unit during the coming school year. Mark one choice for each potential barrier.	Mean	Frequency		
		A major barrier	A minor barrier	Not a barrier
Support for implementation from my school principal/chief administrator	2.78	1	12	50
Support for implementation from my department head	2.83	3	5	55
Support for devoting more time to a single topic (less content topic coverage)	2.30	9	26	28
Planning time before and during implementation of my UbD unit	1.86	19	34	10
My understanding of how to implement UbD units	2.62	1	22	40
My proficiency in using technology visualizations	2.49	4	24	35
Access to computers	2.29	10	25	28
The knowledge level of my students	2.25	7	33	23
The interest level of my students	2.41	4	29	30

Means Rating and Frequencies
Field Test: N = 66
Missing: 3

Table B-4. Institute Process Satisfaction

Rate your level of satisfaction for the following aspects of the institute. Mark one choice for each aspect.	Mean	Frequency			
		Not satisfactory	Somewhat satisfactory	Satisfactory	Very satisfactory
Institute length	3.10	1	8	37	16
Institute daily scheduling	3.19	0	12	26	24
Pace of activities	2.95	4	10	33	15
Institute content overall	3.63	0	2	19	41
Use of audio-visual technology to support content	3.10	6	8	22	26
Meals and amenities	3.15	7	8	16	31
Classroom facilities	3.42	1	7	19	35
Laboratory facilities	3.27	6	7	13	36

Means Rating and Frequencies
Field Test: N = 66
Missing: 4

Table B-5. Instructors and Support

Rate the degree to which each of the following factors helped you to achieve the goals of the institute. Mark one choice for each factor.	Mean	Frequency			
		Helped Very Little	Helped Somewhat	Helped	Helped Very Much
Knowledge level of instructors	3.56	0	5	17	40
Level of difficulty of institute content overall	3.11	1	11	30	20
Level of assistance provided with content	3.42	1	5	23	33
Level of interaction with instructors	3.69	0	4	11	47
Level of interaction with fellow students	3.81	0	1	10	51

Means Rating and Frequencies
Field Test: N = 66
Missing: 4

Table B-6. ESBD in Comparison with Other Professional Development

Rate aspects of this institute in comparison with similar professional development activities in which you have participated. Mark one choice for each aspect.	Mean	Frequency			
		Below average	About average	Among the best 15%	Best of all
Concern for student experience	3.24	0	4	39	19
Content	3.06	1	12	31	18
Quality of instruction	3.08	0	13	31	18
Practical value	3.23	1	6	33	22

Means Rating and Frequencies
Field Test: N = 66
Missing: 4

Table B-7. Effectiveness of Teaching and Learning Strategies

How effective overall were each of the following teaching and learning strategies and topics in the institute? Mark one choice for each item.	Mean	Frequency			
		Not effective	Somewhat effective	Effective	Very effective
Daily reflections	2.69	1	25	28	8
Whole-group discussions	3.40	1	4	26	31
Small-group discussions	3.50	0	7	17	38
Small group work and activities	3.44	0	8	19	35
Readings	2.82	2	17	33	10
Designing UbD units (small group work)	3.63	2	1	15	44

Means Rating and Frequencies
Field Test: N = 66
Missing: 4

Table B-8. Effectiveness of Teaching and Learning Topics

How effective overall were each of the following teaching and learning strategies and topics in the institute? Mark one choice for each item.	Mean	Frequency			
		Not effective	Somewhat effective	Effective	Very effective
Designing and using rubrics	2.58	6	23	24	9
Designing performance assessments (small group)	3.21	1	10	26	25
Using WHERE to design instruction	3.32	0	5	32	25
Addressing student misconceptions (preconceptions)	3.31	1	8	24	29
Using visualizations to enrich instruction	3.50	0	5	21	36

Means Rating and Frequencies
Field Test: N = 66
Missing: 4

Table B-9. Relevance of Activities

How relevant was each of the following to the goals of the institute? Mark one choice for each item.	Mean	Frequency			
		Not relevant	Somewhat relevant	Relevant	Very relevant
Whole-group discussion of misconceptions (preconceptions)	3.31	0	6	31	25
Presentation on rubrics	2.74	3	18	33	8
Group work on rubrics	2.63	5	19	32	6
Visualization presentations	3.44	1	3	26	32
Web search on visualizations	3.48	2	2	22	36
Daily reflections	2.92	1	18	28	15

Means Rating and Frequencies
Field Test: N = 66
Missing: 4

Appendix C. Field Test Staff Developer Questionnaire and Results

Survey Questions

Survey Section 1: Background and Experience

Question 1. Time Dedicated to Staff Development

What percentage of your time, overall, is devoted to staff development?	
Less than 25%	1
About 25%	2
About 50%	3
About 75%	4
About 100%	5

Question 2. Conducted Institutes Comparable to ESBD

Approximately how many staff development summer institutes comparable to the Earth Science by Design (ESBD) program have you conducted in the past?	Open

Question 3. Years of Experience as a Staff Developer

How many years have you worked as a staff developer?	Open

Question 4. Formal Earth Science Education

Do you have formal education background in Earth science?	
No	1
Yes	2
If yes, please describe	Open

Question 5. Other Formal Science Education

Do you have formal education background in some other science?	
No	1
Yes	2
If yes, please describe	Open

Survey Section 2: Institute Staffing

Question 6. ESBD Institute Staff and Expertise

Describe the staff that assisted you in delivering the institute and their roles.	Open

Question 7. Sufficiency of ESBD Staff

Who on your staff provided Earth science content expertise? Was it sufficient for the needs of the institute?	Open

Survey Section 3: Implementation Context

Question 8. Advertisement of ESBD

How was the Earth Science by Design opportunity advertised to teachers?	Open

Question 9. Teacher Selection

How did you select teachers to participate in Earth Science by Design?	Open

Question 10. Reimbursement for Teacher Participation

Did teachers receive any financial support or incentive for participation?	
No	1
Yes	2
If yes, please describe	Open

Question 11. Description of Participating Teachers

Overall, describe the group of teachers who participated.	Open

Question 12. Teachers' Reasons for Participating

What do you think were their reasons for participating?	Open

Survey Section 4: Technology and Facilities

Question 13. Technology Infrastructure

Mark the choice that best describes the technology infrastructure at the ESBD summer institute.	
No computer or Internet access	1
Limited or intermittent computer and Internet access	2
Consistent computer and Internet access	3

Question 14. Technology Access by Teachers

Mark the choice that best describes teachers' access to technology.	
Individual (1-to-1 computer access)	1
Shared between teachers (2 or more users per computer)	2
Not Applicable	3

Question 15. Technology Support

Mark the choice that best describes the technology support available onsite.	
No support available	1
Insufficient support	2
Sufficient support	3
Excellent support (immediate support for all 10 days)	4

Question 16. Adequate Facilities

Were your facilities (rooms, work surfaces, etc.) adequate?	
No	1
Yes	2
If no, please describe in what ways were they inadequate?	Open

Survey Section 5: Preparing for and Delivering the Summer Institute

Question 17. ESBD Preparation in Comparison with other Professional Development programs

Think about ESBD in relation to other TPD programs you offer or have offered. How does ESBD compare to these programs in terms of the amount of time and effort required for staff to prepare?	Open

Question 18. ESBD Delivery in Comparison with other Professional Development programs

How does ESBD compare to other TPD programs you have offered in terms of the amount of time and effort required for staff to deliver the program?	Open

Question 19. ESBD Prior Training

To what extent, in your estimation, could prior training for your staff on the ESBD program have improved your implementation? For example, would a half-day of prior training have helped? Why or why not?	Open

Survey Section 6: Evaluation of Materials

Question 20. Utility of ESBD Videos

Think about the ESBD videos that you were asked to show during the second week of the institute. Please comment on whether or not they were useful. If they were useful, please describe in what way.	Open

Question 21. Effectiveness of ESBD Handbook

Please rate the effectiveness of the ESBD Handbook by marking one choice for each item below. The ESBD handbook:	
Strongly disagree	1
Somewhat disagree	2
Somewhat agree	3
Strongly agree	4

Question 22. ESBD Handbook in Comparison with Other Professional Development Handbooks

How does the ESBD Handbook compare to other handbooks for teacher professional development workshops that you have used? Mark one choice.	
Less effective	1
About as effective	2
More effective	3
The best I've used	4
No basis for comparison	5

Question 23. Suggestions to Improve the ESBD Handbook

Thinking about topics or areas that you think the ESBD Handbook could have addressed or supported better, what are your suggestions for its improvement?	Open

Question 24. Effectiveness of Online Unit Planner

Please rate the effectiveness of the online unit planner by marking one choice for each item below.	
Strongly disagree	1
Somewhat disagree	2
Somewhat agree	3
Strongly agree	4

Question 25. Suggestions to Improve the Online Unit Planner

What recommendations do you have for improvement of the online unit planner?	Open

Question 26. Teachers' Reactions to Daily Online Reflections

Please comment on the teachers' reactions to doing the daily online reflections.	Open

Question 27. Review of Teachers' Reflections

Did you read the teacher reflections each day before the beginning of the next day's work?	
No	1
Yes	2

Question 28. Value of Teachers' Reflections

Comment on the value of the reflections to you. How did you use the reflections?	Open

Question 29. Teachers' Use of ESBD Web site Resources

Did teachers make use of resources on the ESBD Web site during the institute?	
No	1
Yes	2

Question 30. Utility of Web site Resources by Teachers

In what ways did teachers find these resources helpful or not helpful?	Open

Question 31. Provision of Additional Curriculum by School Districts

Did the teachers' school district provide additional curriculum resources to integrate into your implementation of ESBD?	
No	1
Yes	2
If yes, please describe	Open

Question 32. Utility of District Resources by Teachers

In what ways did teachers find these resources helpful or not helpful?	Open

Question 33. Creation of Additional Resources

Did you use materials you or your staff have created for other teacher professional development offerings during the institute?	
No	1
Yes	2

Question 34. Utility of Additional Resources by Teachers

In what ways did teachers find these resources helpful or not helpful?	Open

Survey Section 7: ESBD Program Implementation

Question 35. ESBD Program Implementation Satisfaction

Overall, how satisfied were you with the implementation of the ESBD program during the summer institute? Mark one choice	
Not satisfied	1
Somewhat satisfied	2
Satisfied	3
Very satisfied	4

Question 36. Description of Program Overall

Please describe how you think the summer institute went, on the whole. What went really well? What didn't go well?	Open

Question 37. Skills Enhancement

Please rate the effectiveness of the institute in helping teachers acquire skill in each of the areas below.	
Ineffective	1
Somewhat effective	2
Effective	3
Very Effective	4

Question 38. Characterization of Teachers' Response to ESBD

Overall, how would you characterize teachers' response to this program? What would you say teachers' most valued in the program?	Open

Question 39. Description of Teachers for whom the ESBD Program is Inappropriate

Are there any kinds of teachers for whom you think the ESBD program is not valuable or appropriate? If so, please describe.	Open

Question 40. Adjustments Made to ESBD Materials

Please describe any adjustments, changes, or additions that you made to ESBD materials in your implementation of the institute.	Open

Question 41. ESBD Program as Meeting Professional Development Goals

Thinking about the teacher professional development objectives you had in mind when your organization decided to implement ESBD, please comment on how effective overall the ESBD summer institute was in addressing those objectives?	Open

Question 42. Orientation of ESBD Program Curriculum: Pedagogy or Content

To what extent do you view the ESBD program as a content-oriented curriculum and to what extent do you view it as a pedagogy-oriented curriculum? Please state the reasons for your views.	Open

Question 43. Post-Institute Contact

Have you had any contact with participating teachers since the summer institute?	
No	1
Yes	2

Survey Section 8: Post-Institute Support to Teachers

Question 44. Staff Availability to Contact Teachers

Please describe the staffing available to review and provide feedback on teachers' units and the frequency of contact you expect to have with teachers prior to the fall conference.	Open

Question 45. Mode of Post-Institute Communication

To what extent will your post-institute contact with teachers throughout the 2004-05 school year involve the following?	
Not at all	1
In response to requests	2
1-3 times each	3
More than 3 times each	4

Question 46. Plans for Staff Developer Observation

Please describe your plans for staff developers' observation of teachers' implementation of the units they designed for ESBD.	Open

Question 47. Plans for Peer Observation

Please describe your plans for peer observation of teachers' unit implementation.	Open

Question 48. Additional Comments

If there is anything we have forgotten to ask that you would like to share with us about the field test experience, please use this space for your thoughts.	Open

Survey Answers[2]

Survey Section 1: Background and Experience

Table C-1. Time Dedicated to Staff Development

Mean	Frequency				
	Less than 25%	About 25%	About 50%	About 75%	About 100%
3.43	1	0	3	1	2

Means Rating and Frequencies
Field Test: N = 7
Missing: 0

Table C-2. Conducted Institutes Comparable to ESBD

Response:	~10, depends on the meaning of comparable
Response:	12
Response:	2
Response:	3
Response:	20 or more
Response:	0, earlier ones were of shorter duration or less in depth content issues

Open-Ended Responses
Field Test: N = 7
Missing: 1

Table C-3. Years of Experience as a Staff Developer

Response:	15
Response:	35
Response:	4
Response:	6
Response:	25
Response:	7
Response:	15

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-4. Formal Earth Science Education

Frequency	
No	Yes
4	3

Field Test: N = 7
Missing: 0

[2] To protect the anonymity of respondents, specific names and locations have been deleted from survey answers.

Table C-5. Description of Formal Earth Science Education

Response:	Certified 6-12 Earth Space, 18 undergraduate hrs, 16 graduate hours in Earth Space related courses
Response:	Graduate level course work
Response:	Science classes at the college level.

Open-Ended Responses
Field Test: N = 7
Missing: 4

Table C-6. Other Formal Science Education

Frequency	
No	Yes
1	6

Field Test: N = 7
Missing: 0

Table C-7. Description of Other Formal Science Education

Response:	Background of general science grades K-8
Response:	Biology, Chemistry
Response:	I don't have a degree in science, but have many units in biology and astronomy.
Response:	MS in marine sciences (ecology: community interactions); general oceanography; doctoral level environmental science course work
Response:	original degree in Dental Hygiene so broad background in biological and health related sciences along with chemistry
Response:	physics

Open-Ended Responses
Field Test: N = 7
Missing: 1

Survey Section 2: Institute Staffing

Table C-8. ESBD Institute Staff and Expertise

Response:	Professor of Geology at…[a] community college; [two] high school Earth science teachers
Response:	[A state] high school teacher of the year provided invaluable earth science and curriculum originally expertise. [Another staff member from a 4-year university] also provided valuable consultation on atmospheric and space-related issues. [A staff member], a new program manager at a [local] botanical garden, helped in facilitating teachers' curriculum design process. He has 20+ years of teaching experience in a 7-12 private school.
Response:	I had one additional staff member because of the small size of the participants. He was an earth science content expert and staff development faculty member at [a university]; many years of teaching and conducting professional development courses with science teachers. His role was a co-facilitator; we both presented material and co-directed the institute.
Response:	One other staff member assisted with this institute. We shared the presentations, and we planned and collaborated on any adaptations we felt were original. She originally began her career as a secondary social studies teacher. She moved to professional development over 10 years ago. She has a strong interest in reading issues and development and testing optimal strategies for teaching children. She is very comfortable crossing content when the focus is on learning. She is a national CRISS trainer and has more experience with Understanding by Design than I do.
Response:	Science Center Director, former middle school science teacher...taught about a third of the lessons [Another staff member] middle school science teacher with emphasis on Earth science....has taught numerous workshops on the subject...taught about a third of the lessons and was main resource in regards to Earth science
Response:	Three consultants with Curriculum Development and Earth science teaching experience.
Response:	Three middle school science teachers and one high school earth science teacher were the staff members who are working with me. They presented sections of the summer institute and were assigned 2, 3, or 4 teachers they worked with and will continue to work with.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-9. Sufficiency of ESBD Staff

Response:	Yes, it was sufficient.
Response:	I provided the Earth science content. For the most part I was comfortable with this. I had spent time working with AGI and earth systems science prior to this institute. This provided good background for many of the issues that the middle school teachers were struggling with.
Response:	Yes
Response:	Primarily [one staff member], although both teachers provided content expertise and I provided content expertise in astronomy. It was more than sufficient.
Response:	I believe it was sufficient based on reflections of the participants
Response:	The high school earth science teacher, and for any space science related units, one of the middle school teachers and I gave help. We gave direct help and also brought in additional resource materials when they were needed.
Response:	The two principal staff members provided content material; our knowledge was more than enough to direct this institute.

Open-Ended Responses
Field Test, N=7
Missing: 0

Survey Section 3: Implementation Context

Table C-10. Advertisement of ESBD

Response:	Brochures describing the program were sent to all middle schools in NH; brochures went out through the regional IMPACT Centers (VT, ME, MA, NH) and this were sent out electronically to school districts; brochures were distributed at state science conference
Response:	Electron network, workshop announcements, hard copy mailing
Response:	I invited teachers I felt would contribute a lot to the program and who would be willing to work hard.
Response:	Originally by personal invitations and then by discussions with teachers who had accepted and felt they knew an additional candidates.
Response:	Through a database maintained by Science Pioneers to 45 school districts in the Greater City area
Response:	Through several Garden-developed fliers, announcements at teacher meetings and on the Garden's web site. Our most effective means was a targeted mailing to middle school teachers with whom we had worked before.
Response:	Two flyers, e-mails to list-serves and numerous phone calls to local schools.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-11. Teacher Selection

Response:	Any who qualified could participate.
Response:	If they met baseline criteria (teach middle school, have some comfort with technology, and intend to implement the unit they design), they were accepted. We didn't exactly have an excess of applicants, though some were discouraged from applying if they were not middle school teachers or if they didn't intend to participate in the full institute. One pair, for example, wanted to tag team the institute and share what they learned back at school.
Response:	If they met the criteria of teaching middle school and taught some earth science units; expressed a valid interest in teaching earth science as part of professional growth.
Response:	only had 18 apply, 15 of whom could attend at the time of enrollment on the internet, and 12 who could attend...other had conflicts come up
Response:	Please see above: [Through a database maintained by Science Pioneers to 45 school districts in the Greater City area]. I tried to balance new and experienced teachers, from all areas of the district. If I invited them, they were accepted.
Response:	Review of their application, teaching experience, and Earth science teaching responsibilities
Response:	We tried to develop pairs at middle schools for support but finally had to accept single teachers from half of the middle schools. We did not have more completed applications than we could handle.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-12. Reimbursement for Teacher Participation

Frequency	
No	Yes
0	7

Field Test: N=7
Missing: 0

Table C-13. Description of Teacher Reimbursement

Response:	$350 to attend and could pay $200 for 4 hours of graduate credit at [a] University
Response:	$500.00 stipend plus 45 hours of salary increment credit which means an additional $500.00 on the salary schedule.
Response:	$750 stipend plus some materials beyond what ESBD provided, such as teaching units (GEMS Seasons), software (Riverside Scientific Seasons, Winds, Clouds, Storm Systems and New Moon) and a classroom watershed model.
Response:	Hours of credit to fulfill requirements of being certified in Earth science under No Child Left Behind
Response:	Minimally, a $200 stipend was paid at the end of the summer institute. Budget permitting, we will pay more at the end of the program. Several also took advantage of cut-rate graduate credit (about $75/credit for private college tuition).
Response:	Stipend for the 2 week institute, part-time hourly to work on unit during personal time, $200 for equipment to support unit, and district pay of substitutes for peer visits. Teachers were also invited to attend a 3 day Understanding by Design workshop set up through our USI grant and the district last May.
Response:	Teachers received the following: three graduate credits; lunch and snacks during the day; a weekly evening cookout.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-14. Description of Participating Teachers

Response:	Mixed. One was remarkably weak in both pedagogy and content knowledge; the others were pretty mainstream teachers willing to go along with the program, but none were particularly strong in either content or pedagogy. They did, however, grow considerably in their teaching worldview over the course of the two weeks.
Response:	Most did not have formal educational background in any Earth science fields, although all had taught some Earth science topics previously. Grades ranged from 5th—8th (5th grade is responsible for middle school science standards in [the same State]). Teachers collaborated well during the workshop. All were enthusiastic about what they were learning and the opportunity to create and/or enhance their teaching units.
Response:	Teachers represented 5 School Districts. Each had Earth science teaching responsibilities. All were interested in learning about ESBD model of curriculum development
Response:	They range in age from mid-twenties to fifties. They are Anglo or Hispanic. The experienced teachers are committed professionals who are life-long learners. I have worked with them for several years. They are all teacher leaders. The new teachers are hard-working and very enthusiastic about teaching. I wanted them to interact with the veteran teachers so they would gain a better sense of what being part of the profession means. Their fresh outlook was energizing for the veteran teachers.
Response:	They were an energetic and enthusiastic group; they worked diligently at the tasks.
Response:	They were of all ages and experience. We had extremely good discussions and everyone worked well together to develop units.
Response:	We had a wide cross section of experience; from over 30 years to just completed their first year. Most had little formal experience with Earth science. About 1/3 of them were Teacher Leaders and 2 were National Board Certified. We ended with 2 males, and 6 African Americans out of the 14 who finished the summer institute.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-15. Teachers' Reasons for Participating

Response:	College credit, stipend, enhancing teaching units. Incidentally they learned more content. (I'm guessing at this, but conversations during the workshop seemed to indicate this).
Response:	Interest in both the earth science content and the alternative pedagogy seemed to be dominant drivers. The $$$ and credits were nice, but didn't seem to be major motivators.
Response:	Personal and professional interest in the earth sciences.
Response:	Quite varied. I need the money, I'll come because I was invited, and all the way up to I want to find out if this really will make a difference. No one, including me, realized what we were getting into! Those that had some background in UbD and Earth science for the first time.
Response:	Several were going to implement UbD in their classrooms by district mandate. Others were gong to be teaching Earth science for the first time.
Response:	Strong commitment to professional growth and a desire to further than own background knowledge in the earth sciences; UbD format for unit design.
Response:	They like to do summer workshops, and I think they realized that learning about backward design would help us improve our program. The stipend and the salary increment credit also helped attract them. I think they trust me and my judgment that this would be a valuable experience for them.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Survey Section 4: Technology and Facilities

Table C-16. Technology Infrastructure

Mean	Frequency		
	No computer or Internet access	Limited or intermittent computer and Internet access	Consistent computer and Internet access
3.00	0	0	7

Mean and Frequencies
Field Test: N=7
Missing: 0

Table C-17. Technology Access by Teachers

Mean	Frequency		
	Individual (1-to-1 computer access)	Shared between Teachers (2 or more users per computer)	Not Applicable
1.00	7	0	0

Mean and Frequencies
Field Test: N=7
Missing: 0

Table C-18. Technology Support

Mean	Frequency			
	No support available	Insufficient support	Sufficient Support	Excellent support (immediate support for all 10 days)
3.57	0	0	3	4

Mean and Frequencies
Field Test: N=7
Missing: 0

Table C-19. Adequate Facilities

Frequency	
No	Yes
0	7

Field Test: N=7
Missing: 0

Survey Section 5: Preparing for and Delivering the Summer Institute

Table C-20. ESBD Preparation in Comparison with other Professional Development Programs

Response:	I think preparing by reading and learning the scripts was relatively easy, but I did not feel that I was expert enough in the understanding by design process. I was learning along with them, which is not a bad thing, but I would have felt more comfortable had I had a stronger background.
Response:	I think there more than sufficient time before the institute to prepare. Although I am familiar with the UbD format; some further 'advice' on implementation would be most helpful. On a daily basis, it meant that staff had to review and prepare into the evening hours.
Response:	Most long-term summer workshops that we offer are only one week. Given that, the amount of time and effort was similar.
Response:	Most of the PD that I am involved in does not provide the time to allow for this depth of training. The amount of reflection and the depth that teachers were forced to deal with teaching strategies and content issues mandated a higher level of time and effort on our part to meet and anticipate their needs. Your materials were excellent but like any program, require more than just reading the words by the presenter.
Response:	Preparation was about the same in terms of time and effort. The other programs I run operate from a similar conceptual framework, so there wasn't a noticeable difference.
Response:	The concept was not new to us. It required the staff to study your system and put it into operation.
Response:	The time to prepare was similar to other programs I have implemented.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-21. ESBD Delivery in Comparison with other Professional Development programs

Response:	As with preparation, delivery efforts were consistent with the other workshops we ran this summer (and in the recent past).
Response:	High level, both before and during. We tried to anticipate each day's needs prior to beginning the institute but often found ourselves spending 2 to 3 hours after each day preparing for the next day as they reacted to the material.
Response:	In previous TPD programs I have done and continue to do, I had to start from scratch and write my own script. For this one, the script was done so it was just a question of following the script, reading and preparing, making sure the technology was up and running, etc.
Response:	More time because of the daily preparations and required follow-up during academic school year
Response:	The time and effort was similar to other programs.
Response:	There is sufficient time to deliver the program; although 10 consecutive full days is stressful for teachers.
Response:	This program was of a similar length and I did not feel pressured time wise.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-22. ESBD Prior Training

Response:	A half-day might have helped to provide a general orientation to what each day would accomplish. We spent several days going through the agenda thoroughly, assigning roles to each presenter, making sure materials were available, etc. and we would still need to do this even with a half-day orientation, although we might have gone through things more quickly with the orientation. For example, there were connections between certain days that we didn't see at first and had to figure out as we went along. Also, not having the finalized version of the agenda until right before the workshop made the preparation a little more difficult.
Response:	A one-day session would be most helpful to review the specific goals and review the UbD format and ESBD focus using UbD.
Response:	In our case, I'm not sure it would be important. We met as a staff for a few hours before the institute, and had intermittent team meetings as needed throughout the institute, which seemed sufficient. If we didn't have previous working relationships, this might have been more of an issue.
Response:	We devoted all the time we needed for preparation as part of our normal schedule
Response:	We would have been able to anticipate more. Both [other staff member] and I can't imagine how one could adequately facilitate this institute without prior training in UbD. We often relied on our prior knowledge in this area to help our participants make meaningful connections. My personal experiences assisted me with the Earth Systems Science. Prior training would help but the duration is questionable. For us, if we had had a half day we would have only dealt with implementation issues, not the deeper applications issues.
Response:	The backward design is such a valuable process, that I wish we had been able to learn more about it ahead of time.
Response:	Yes, prior training would have been very beneficial. Especially on unit examples.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Survey Section 6: Materials Evaluation

Table C-23. Utility of ESBD Videos

Response:	Although I was not initially confident that the videos would be useful, I must admit that the teachers did learn a lot from the interview sessions. The fact that they were only 9 minutes was beneficial. The teachers learned a lot from these.
Response:	I think they were useful because it put a human face on the program, and because the teachers in the video had many of the same concerns and issues that our teachers were having. It's always good to hear discourse on professional practice that is at a very high level. It raises the bar. Makes us more aware of ourselves as professionals and more intentional about improving.
Response:	I wasn't present when the videos were shown. My co-facilitators did this part of the agenda.
Response:	They were useful because our participants had a chance to hear others comment about the ESBD model
Response:	They were useful in provoking very thoughtful discussions (both the intended videos and the ones we showed in error!) Seriously, they resonated well with the teachers, and really contributed to their ability to firm up their growing comfort with the ESBD/UbD approach to unit design.
Response:	They were useful in that the participants were able to hear from someone else who had experienced the process. But the people talked too fast and sounded like a prepared commercial.
Response:	We both felt they were useful for what they did say. We also felt that our participants wanted to hear more about how early implementers had struggled with learning the process, not so much about the actual implementation. Maybe add an earlier video concerning these issues too.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-24. Effectiveness of ESBD Handbook

	Mean	Frequency			
		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
Offered complete information and resources for instructors' preparation before implementation	3.29	0	1	3	3
Presented adequate instructions and strategies for instructors' implementation of the activities each day	3.71	0	0	2	5
Clearly presented learning objectives and activities for each day and week	3.71	0	0	2	5
Offered complete activities and experiences for teacher-participants to master the targeted concepts and skills	3.43	0	1	2	4
Was effective in helping this organization achieve the objectives for teachers' professional development for which it (ESBD) was implemented	3.57	0	0	3	4
Provided an appropriate level of detail	3.57	0	0	3	4
Was well organized	3.71	0	0	2	5
Was easy to use	3.43	0	0	4	3
Attractively displayed information	3.43	0	0	4	3

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-25. ESBD Handbook in Comparison with Other Professional Development Handbooks

Mean	Frequency				
	Less Effective	About as effective	More effective	The best I've used	No basis for comparison
3.00	0	2	4	0	1

Means Rating and Frequencies
Field Test: N = 7
Missing: 0

Table C-26. Suggestions to Improve the ESBD Handbook

Response:	Being an early implementer we often did not have all the resources until just prior to use. We also felt that the UbD book should be used if only as a reference that visibly helped to tie the program together.
Response:	I think more earth science content dealing with Earth as a system needs to be addressed.
Response:	In general, it did a very good job of supporting implementation. Since this was a field test, the level of prescriptiveness was no doubt deliberate. In public dissemination, adding options and extensions might be helpful. Also, as a minor matter of appearance, varying the fonts etc. for some aspects might help (e.g. web sites on p. 135)
Response:	Please see daily site reflections. There were several parts missing from the handbook that we had to create.
Response:	Too much time was devoted to the Rock Cycle as an example. Teachers already understood the model and were ready to move on
Response:	We needed to add a more sophisticated way for teachers to review and analyze the scope and sequence of the teaching activities in their units. The analysis form you provided was too general, mostly listing the steps of WHERE without asking the teachers to critique their materials or look at how they fit together.
Response:	We were given two books, the Wiggins and McTighe, and the Dr. Art, but there were no indications of when the participants should read them. Ideally, the books would be read ahead of time by everyone, so that during the workshop, some degree of basic understanding would be there already. I felt the first two days were too crowded and we weren't able to do the topics justice.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-27. Effectiveness of Online Unit Planner

	Mean	Frequency			
		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
Was easy for teachers to access	3.29	0	2	1	4
Was easy for teachers to use	3.00	0	2	3	2
Helped the teachers to design their units	3.57	0	0	3	4

Means Rating and Frequencies
Field Test: N = 7
Missing: 0

Table C-28. Suggestions to Improve the Online Unit Planner

Response:	Compared with UbD Exchange, this was much more user-friendly. I would suggest offering access to a wider pool of units as the project achieves a critical mass of teachers.
Response:	It needs to have expanding sections because participants ran out of space on some sections. Participants would sometimes not be able to get their units or got other people's units!!
Response:	Most teachers had few problems. Sometimes items were lost but I'm not sure who was responsible. Teachers indicated the desire to be able to put tables directly into their units along with cutting and pasting from word.
Response:	Needed a way to import a table and graphics into the unit plan.
Response:	Sections should not be broken up; the teachers should be able to scroll from one section to the other, rather than closing down. More frequent reminders to save before closing would also be useful. I think there wasn't a format for the rubrics (?)
Response:	They had problems using the software. We had to call several times for instructions

Open-Ended Responses
Field Test: N = 7
Missing: 1

Table C-29. Teachers' Reactions to Daily Online Reflections

Response:	I think that they saw it as part of their duties, rather than as part of the learning approach of ESBD (to be reflective on a daily basis about one's teaching and students' learning).
Response:	Teachers' seemed to 'like' doing these reflections.
Response:	They complained on some days, but it was a good strategy. It helped us to know what they were thinking. We were able to react to their comments, which was very important to us. As a result all of them left the workshop with a very positive attitude, even those who did not understand the model at first.
Response:	They didn't seem to think it was a burden at all. I think they got to like the process. Some wrote more than others, some were more perfunctory about it than others, but in general, I think they took it seriously and gave good input.
Response:	They seemed to like the fact that they had input and I would read them each night and address their concerns the next morning.
Response:	They were amenable to doing it, and after a couple of days didn't need any reminders to do it.
Response:	We believe that most of them took it seriously. Their reflections were very insightful for us. The fact that it was online was a plus. I would like to develop that format for our local professional development workshops.

Open-Ended Responses
Field Test: N = 7
Missing: 1

Table C-30. Review of Teachers' Reflections

Frequency	
No	Yes
3	4

Field Test: N = 7
Missing: 0

Table C-31. Value of Teachers' Reflections

Response:	Assisted in directing the next day's activities and concerns raised by the teachers.
Response:	I tried to read every day; A few days had other schedule issues arise (doing double job duty during the summer, which wasn't anticipated when we started the process...)
Response:	I used them to start the following day, in the 15 minute startup. I referred to the general tone of the reflections and also to some specific concerns. It gave the others a sense of what was important to most of the group, or to individuals. I didn't name anyone.
Response:	Reflections drove what we did the next day. Helped us to understand their level of acceptance, misconceptions still present, and confusion of issues. It was part of the roadmap for the next day's work.
Response:	see above: [They seemed to like the fact that they had input and I would read them each night and address their concerns the next morning].
Response:	To judge the level of understanding of the participants and their attitude toward the workshop
Response:	We read their reflections during the first week, before each new day, but gave up after awhile. They became mostly a way for the teachers to provide you with feedback about the course, rather than to help us plan the next day.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-32. Teachers' Use of ESBD Web site Resources

Frequency	
No	Yes
0	7

Field Test: N = 7
Missing: 0

Table C-33. Utility of Web site Resources by Teachers

Response:	Almost all of websites were new to them. They usually do not have the time to search websites during their busy teaching schedule.
Response:	I think they got a chance to see what other teachers had developed in previous workshops.
Response:	It gave them a place to start for visualizations and misconceptions which they liked. Most of them took the seeds you provided and went off on their own. Dr. Arts book seemed to have little overall relevance during the 2 weeks.
Response:	not sure
Response:	Teachers responded quite favorably to the resources, and many found their way into the units. More generally, they served to introduce the notion of visualizations for some. Participants also shared many other sites with each other.
Response:	The visualizations were extremely helpful.
Response:	They considered the resources great sources of information.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-34. Provision of Additional Curriculum from School Districts

Frequency	
No	Yes
3	4

Field Test: N = 7
Missing: 0

Table C-35. Description of Additional Curriculum from School Districts

Response:	Comprehensive curriculum with ES in each grade level. Newly designed curriculum using the UbD format.
Response:	Textbooks, lab manuals, state science frameworks
Response:	The teachers were told to work from our district core curriculum materials and to develop additional lessons as needed.
Response:	They could go back to their schools and pick up text and resource materials

Means Rating and Frequencies
Field Test: N = 7
Missing: 3

Table C-36. Utility of District Resources by Teachers

Response:	It gave them a framework. They have the materials they need to do the activities.
Response:	Most got hung up on the role of the state standards and NCEE standards. Once we got over that hurdle it was better. The curriculum helped them define their EQ and EU.
Response:	No particular district was represented in the institute. Teachers did make use of local district materials, however, such as curriculum guides, textbook resources, etc.
Response:	They needed to be able to merge the ESBD and UbD focus into their existing curriculum program.
Response:	They were able to design their curriculum models based upon the curriculum framework approved by their school district

Means Rating and Frequencies
Field Test: N = 7
Missing: 2

Table C-37. Creation of Additional Resources

Frequency	
No	Yes
2	5

Field Test: N = 7
Missing: 0

Table C-38. Utility of Additional Resources by Teachers

Response:	Excellent supplements to the ESBD materials.
Response:	Helped to clarify overarching UbD concepts.
Response:	In the interest of not contaminating the field test process, no major local changes were made in the resources provided.
Response:	Several teachers found our checklist, which matched the components of their units to the state benchmarks, to be very helpful. This was a way of analyzing the unit components and thinking about how the sequence of activities was working together (beyond WHERE)
Response:	they gave additional ideas for materials and activities
Response:	We have a large collection of materials gathered from various county, state and U.S. agencies

Means Rating and Frequencies
Field Test: N = 7
Missing: 1

Survey Section 7: ESBD Program Implementation

Table C-39. ESBD Program Implementation Satisfaction

Mean	Frequency			
	Not satisfied	Somewhat satisfied	Satisfied	Very satisfied
3.57	0	0	3	4

Mean and Frequencies
Field Test: N=7
Missing: 0

Table C-40. Impressions of Program Implementation

Response:	Fort what we had, it went very well. The low numbers limited the richness of diverse voices, but it was clear by the end that the institute had a significant impact on teachers' perceptions and approaches to curriculum. We'll see how this impacts practice.
Response:	I was quite pleased at the level of work the teachers accomplished. Once they understand the various components of the UbD format, they were able to really think about what they were doing. Ten intense days in a row is somewhat stressful; although I am not sure how to change this intensity other than to extend the time period. Teachers needed more time to 'digest' the content and UbD format.
Response:	It went very well. Teachers were satisfied with the content, the activities, and the relationships they built with each other. They are looking forward to the continued work in fall and winter. They also greatly appreciated the depth of knowledge, examples, resources, and materials that George Econ, our geology professor, provided.
Response:	The teachers went from confusion and discomfort to a greater level of comfort in using the understanding by design process. Most of it went well. A few of the presentations were not as effective as they could have been, and time was not always sufficient for all topics.
Response:	We saw quite a bit of teacher growth in many of the participants. Teachers felt empowered to finish their units when they left. They felt a real sense of accomplishment. Many days our timing was off so we often wonder if we did not present everything in adequate depth.
Response:	We were very pleased with the program. Especially the attitude of the teachers. The online connections with TERC were very helpful and supported the institute very well.
Response:	please refer to daily site reflections

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-41. Skills Enhancement

	Mean	Frequency			
		Ineffective	Somewhat effective	Effective	Very effective
Apply the Understanding by Design approach	3.57	0	0	3	4
Understand the "Big Ideas" in Earth science	3.29	0	0	5	2
Evaluate visualizations and use them effectively in teaching	3.57	0	0	3	4
Design and use performance assessments	3.14	0	0	6	1
Design and use rubrics for performance assessments	3.00	0	1	5	1
Use assessments formatively to modify teaching and guide student learning	2.86	0	1	4	1
Construct a sequence of learning activities using the WHERE model	3.29	0	0	5	2

Means Rating and Frequencies
Field Test: N = 7
Missing: 0

Table C-42. Characterization of Teachers' Response to ESBD

Response:	Everyone had a very positive respond to the program. I think they valued most the organizational method they learned.
Response:	I think teachers really valued having two weeks to really focus on one unit. I think they valued learning the backward design process. I think the interaction with other teachers was positive.
Response:	I think thoroughly enjoyed the program.
Response:	Our teachers were very positive and appreciated the opportunity to participate in this ESBD model project
Response:	see #40 above: [We saw quite a bit of teacher growth in many of the participants. Teachers felt empowered to finish their units when they left. They felt a real sense of accomplishment. Many days our timing was off so we often wonder if we did not present everything in adequate depth].
Response:	Teachers were very positive by the end, though the first few days were a bit intense. By the end, though, all of the 'survivors' remarked how much they had learned and how valuable the process had been.
Response:	Those that finished the institute had a positive response. I'm not sure what they valued most but I think it was the non-threatening learning atmosphere and the generous amount to time to process the information.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-43. Description of Teachers for whom the ESBD Program is Inappropriate

Response:	No
Response:	No
Response:	Teachers who are at the end of their career and not interested in making significant changes in their teaching strategies
Response:	Teachers with very weak content and/or rigid pedagogies would likely not find this productive.
Response:	Those that are not open to change or do not see teaching as more than just a job.
Response:	Unfortunately there are teachers who don't want to change. They feel what they are doing is just fine, and don't want to think about how to do things better. I did not invite any of those to participate.
Response:	We had a wide range of teachers in the program, and they all seemed to benefit from it. We even had a school counselor who teaches hot-air ballooning and is very interested in science, and she benefited from the course.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-44. Adjustments Made to ESBD Materials

Response:	Adjustments were minor. We felt that the materials and activities you provided were great and helped the teachers with their growth. We might recommend using the UbD book or workbook more in the future.
Response:	No major ones, except for inadvertently not using the correct reflections video.
Response:	please see daily site reflections
Response:	Stated earlier and in reflections and in the phone conversation with external evaluator.
Response:	We had to add time and then shorten time allotted to the topics. We followed the script almost exactly, but modified the times.
Response:	We related the model to the [State] Science Benchmarks that the teachers would be required to implement in their units
Response:	We shortened the rock cycle activities because the teachers understood the process without belaboring the point. During the second week, we found the teachers needed an intellectual break from writing and thinking about their units. We went on a filed trip to Franconia Notch with a state geologist and discussed some real geological processes.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-45. ESBD Program as Meeting Professional Development Goals

Response:	I believe I need to see the total year before I can adequately rate teacher's growth. AT the moment, both the science supervisor and I both believe that these teachers know more about UbD than any other teacher in the district.
Response:	I think the program addressed our major goals most efficiently.
Response:	I wanted our teachers and me to become more familiar with the understanding by design process so that we could look critically at our middle school curriculum and strengthen it. I think the summer institute was very useful in that respect. We will continue to use backward design for all our professional development classes this school year. We will use it to align our curriculum with the new state standard just approved last May,
Response:	It supported our continuous PD efforts and the PD goals of the school districts we service
Response:	The program was very effective in further developing our institutional commitment to UbD-based approaches to professional development.
Response:	They were very effective and I feel everyone attending left with a positive feeling and a much broader knowledge base.
Response:	With the few additions we made, the program was effective at addressing our PD goals.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-46. Orientation of ESBD Program Curriculum: Pedagogy or Content

Response:	ESBD was more pedagogy-oriented because more time was spent on UbD than on Earth science content.
Response:	I think it is more pedagogy-oriented because it is a tool and framework for thinking about what students must know. If teachers do not have an adequate content background, the process is very difficult unless they get guidance on what the big ideas are. Once they have the big ideas, there may be an increase in content understanding as they look for materials to use with their units.
Response:	I view ESBD as more of a pedagogically oriented project. I know the teachers would have liked it to have been more content oriented. It may be beyond the goals of what is to be accomplished, but the incorporation of more earth science content would be beneficial to most middle school teachers who generally have a weak background in the earth sciences.
Response:	It is a blend. One is driven by the other which makes it a perfect teaching tool. Work done in isolation rarely transfers.
Response:	Mostly pedagogy, though based in a strong content framework. It just doesn't provide the essentials of the content base.
Response:	Primarily pedagogy-oriented, although the visualizations helped with the content. The first week's work on rock cycle could have been content-rich except that most of the teachers in our workshop don't teach rock cycle and weren't interested in going into depth on it.
Response:	We viewed it more as pedagogy than content

Open-Ended Responses
Field Test: N = 7
Missing: 0

Survey Section 8: Post-Institute Support to Teachers

Table C-47. Post -Institute Contact

Frequency	
No	Yes
2	5

Field Test: N = 7
Missing: 0

Table C-48. Staff Plans to Contact Teachers

Response:	All staff will do this. We're not sure about frequency yet.
Response:	Teachers will work with their partners and staff will be available via email.
Response:	Three of the staff and I will be available to help with the fall conference. It will be held soon—Sept. 11 and 18. I have contacted all staff and teachers and reminded them to start looking again at the units. The staff members are assigned to specific teachers and they will be looking at the units before Sept. 11.
Response:	The two primary staff members are presently reviewing the units. We are providing feedback to the teachers.
Response:	Two consultants will be available to conduct the post-institute sessions scheduled during the school year.
Response:	We all met at the Science In-service Day prior to school starting. I do communicate with them via email and address their needs.
Response:	We provided daily feedback as the units evolved; we will make 1-2 contacts per teacher prior to the fall conference

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-49. Mode of Post-Institute Communication

	Mean	Frequency			
		Not at all	In response to requests	1-3 times each	More than 3 times each
Email	4.00	0	0	0	7
Telephone	2.57	0	4	2	1
In person	3.29	0	0	4	2

Means Rating and Frequencies
Field Test: N = 7
Missing: 0

Table C-50. Plans for Staff Developer Observation

Response:	I have made appointments to discuss their units and observe their students. I also plan to return during their implementation.
Response:	I plan to visit each classroom at least once while they do their units.
Response:	I will observe the lessons as time and my schedule permit. I have no dates set up at this time.
Response:	Staff will schedule classroom observations after the fall workshops
Response:	This will be worked out between staff and participants as the new school year begins.
Response:	We plan on visiting each teacher.
Response:	We will visit the classrooms to see the units in action at least a couple of times per teacher, if at all possible.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-51. Plans for Peer Observation

Response:	As above: [I have made appointments to discuss their units and observe their students. I also plan to return during their implementation].
Response:	Each teacher plans to be observed by their partners at least once. Some may do videos of lessons.
Response:	I have had teachers begin to make appointments with each other. They know how to access the sub funds and know about the observation tool. We shall see what happens
Response:	Participants will schedule their peer observations based upon their own teaching and district schedules
Response:	teachers have been encouraged to do this; we will provide substitute pay if needed.
Response:	Teachers working at the same school will be able to observe each other's classes. Between school visits may be more difficult to schedule, but I will try to see if they can be done.
Response:	The teachers are working on an observation schedule now.

Open-Ended Responses
Field Test: N = 7
Missing: 0

Table C-52. Additional Comments

Response:	I think with some minor modifications, the format for the ESBD institute is valuable for all middle school science teachers and pre-service teachers as well.
Response:	It was difficult being the first site because not everything was developed as far ahead as I would have liked. It all worked out fine, but I would have been more comfortable with a little more lead time. The problems with getting approval from my district were very worrying. I actually lost sleep over it.
Response:	No
Response:	No, but (Science Supervisor) would like to know if you have any plans to expand this into other content areas?
Response:	This has been a very comprehensive follow-up survey. The OSMTech Center greatly appreciated being involved in this ESBD project

Open-Ended Responses
Field Test: N = 7
Missing: 0

Appendix D. Results for Field Test Implementation/Peer Observation Teacher Survey

Survey Section 1: Teacher Information

Table D-1. ESBD Program Location

	Frequency
Duval County Public Schools	11
Jackson County Math and Science Center	1
Missouri Botanical Garden	3
Oakland County Math and Science Center	4
Plymouth State University	8
San Diego County Office of Education	4
Science Pioneers, Kansas City	9
Tucson Unified School District	6

Field Test: N = 61
Missing: 15

Survey Section 2: Technology Use

Table D-2. Level of Importance of Importance of Technology Use in ESBD Unit

Please rate the level of importance of technology use for your ESBD unit's implementation.	Mean	Frequency
Technology not needed for the unit	3.28	4
Minimally important to the unit's success		8
Moderately important to the unit's success		21
Essential to the unit's success		26

Means Rating and Frequencies
Field Test: N = 61
Missing: 2

Survey Section 3: Teacher Experience

Table D-3. Importance of Time and Support During Fall Mini-Conference

How important were time and support from your ESBD trainers during the ESBD Fall Teacher Conference in completing your unit?	Mean	Frequency
Not important	3.17	4
Somewhat important		8
Important		21
Very important		26

Means Rating and Frequencies
Field Test: N = 61
Missing: 2

Table D-4. Usefulness of ESBD Web Site

How useful was the ESBD Web site in completing your unit?	Mean	Frequency
I did not use it	3.89	5
Not useful		1
Somewhat useful		11
Useful		20
Very useful		22

Means Rating and Frequencies
Field Test: N = 61
Missing: 2

Table D-5. Effectiveness of Online Unit Planner

Please rate the effectiveness of the online unit planner by marking one choice for each item below.	Mean	Frequency			
		Strongly disagree	Disagree somewhat	Agree somewhat	Agree strongly
The unit planner was easy for me to access.	3.6	1	3	14	41
The unit planner was easy for me to use.	3.3	1	4	24	29
The unit planner helped me to design my unit.	3.5	1	2	17	39

Means Rating and Frequencies
Field Test: N = 61
Missing: 3

Table D-6. Other Implementation Factors

	Percent	Count
Teachers whose districts provided release days	29%	(30)
Teachers whose districts provided other forms of support	29%	(30)
Teachers who repurposed existing curricular materials	41%	(42)

Field Test: N = 61
Missing: 3

Table D-7. Teachers Whose Districts Provided Curricular Resources

Did your school district provide curricular resources to assist you in implementing ESBD in the classroom?	Percent	Count
Not applicable	20%	12
None were provided	5%	3
Not sufficiently	10%	6
Sufficiently	52%	32
More than sufficiently	10%	6

Field Test: N = 61
Missing: 2

Table D-8. Difficulties Faced in *Preparing to Implement* ESBD Unit

What kinds of difficulties, if any, did you face in *preparing to implement* your ESBD unit? Mark all that apply.	Yes	No
Finding time to prepare the unit	44	17
Obtaining funds needed for materials	10	51
Needing to deepen content knowledge in order to complete the unit	30	31
Gaining support from colleagues	9	52
Gaining support from school administration	7	54
Experiencing uncertainty related to student assessments	26	35

Table D-9. Difficulties Faced in *Implementing* ESBD Unit

What kinds of difficulties, if any, did you face in *implementing* your ESBD unit? Mark all that apply.	Yes	No
Not enough time during class periods	25	36
Not enough time for the unit overall	29	32
Lack of student engagement	6	55
Lack of experience with UbD	20	41
Uncertainty about how to use data from the assessments	10	51
Lack of administrative support	3	58

Table D-10. Overall Satisfaction with ESBD Units

Please rate your overall satisfaction with the implementation of your ESBD unit.	Mean	Frequency
Not satisfactory	3.09	2
Somewhat satisfactory		12
Satisfactory		23
Very satisfactory		21

Mean and Frequencies
Field Test: N = 61
Missing: 3

Table D-11. Number of Teachers Whose ESBD Unit Addressed Content Typically Taught

Did your ESBD unit address content that you typically teach?	Frequency
Yes	54
No	4

Frequencies
Field Test: N = 61
Missing: 3

Table D-12. Number of Teachers who Plan to Use ESBD Unit Again

Do you plan to use your ESBD unit (perhaps with modifications) next time you teach the same content?	Frequency
Yes	54
No	2
Have not decided	2

Frequencies
Field Test: N = 61
Missing: 3

Table D-13. ESBD Unit Duration Compared to Usual Approach

Please rate the time needed for implementation of your ESBD unit compared with other ways you have covered the same or similar content in the past. Consider only the time needed after you finished the design of your unit.	Mean	Frequency
Not as much time	3.11	3
About the same amount of time		8
Slightly more time		26
Significantly more time		20

Mean and Frequencies
Field Test: N = 61
Missing: 4

Table D-14. Teachers' Evaluation of Instructional Effectiveness of Unit Relative to Duration

Did the educational effectiveness of your ESBD unit offset the amount of time it required?	Mean	Frequency
No	3.11	2
Somewhat but not sufficiently		10
Sufficiently		25
Greatly		20

Mean and Frequencies
Field Test: N = 61
Missing: 4

Table D-15. Adequacy of Preparation for Unit Implementation.

On the basis of the implementation of your ESBD unit, rate the extent to which the ESBD Program prepared you for implementation.	Mean	Frequency
No	3.25	0
Somewhat but not sufficiently		7
Sufficiently		29
Greatly		21

Mean and Frequencies
Field Test: N = 61
Missing: 4

Table D-16. UbD Practices

On the basis of the implementation of your ESBD unit, how effective was the ESBD Program in increasing your ability to do each of the following? Mark one choice for each item.	Field Test
Inform students at the beginning of the unit or course	3.5
Hook and hold students' interest	3.4
Use a variety of strategies to promote understanding	3.4
Facilitate students' active construction of meaning	3.2
Promote opportunities for students to 'reveal their thinking'	3.2
Use questioning, probing, and feedback	3.2
Teach in the context of big ideas and explore essential questions	3.4
Use information from ongoing assessments to adjust instruction	3.1
Use information from ongoing assessments to check student understanding	3.2
Use a variety of resources to promote understanding	3.6

Means Rating and Frequencies
Field Test: N = 61
Missing:

Table D-17. ESBD Practices

On the basis of the implementation of your ESBD unit, how well did the ESBD Program prepare you to do each of the following? Mark one choice for each item.	Field Test
Teach the 'big ideas' in Earth science	3.3
Use visualizations in teaching Earth science	3.4
Design learning experiences that address the big ideas	3.3
Design units according to the UbD principles and procedures	3.4
Design assessments to assess understanding	2.9
Design and apply rubrics for evaluating student work or performances	2.9
Use performance assessments	3.1
Analyze, evaluate, and provide feedback on the learning designs of peers	3.1
Discern and formulate topics 'worthy of understanding'	3.3
Use the WHERE framework to design instruction	3.2
Design curricula that addresses students' misconceptions	3.1
Design assessments to detect students' misconceptions	3.1
Use the notion of 'understanding' to guide instruction	3.2

Means Rating and Frequencies
Field Test: N = 61
Missing:

Table D-18. Satisfaction with Support from TERC and Field Test Staff

Please rate your satisfaction with the support you received from ESBD leaders and mentors, in the following.	Mean	Frequency			
		Not satisfactory	Somewhat satisfactory	Satisfactory	Very Satisfactory
Specific feedback about revising your unit	3.3	1	7	20	27
Practical support and advice for creating or implementing your unit	3.4	1	3	23	28
Social / emotional support for the challenge of unit implementation	3.5	0	6	17	32

Means Rating and Frequencies
Field Test: N = 61
Missing: 6

Table D-19. Effects of Participation in ESBD on Teaching Practices

To what extent has your participation in the Earth Science by Design had the following effects on your teaching practice in general (beyond the implementation of your ESBD Unit) or your knowledge? For each of the areas below, please indicate whether or to what extent you may have changed as a result of participation in the ESBD project.	Mean	Not at all	Slightly	Somewhat	A great deal
Use of Understanding by Design unit planning techniques	3.6	1	3	14	38
Use of Understanding by Design teaching techniques	3.5	1	3	20	31
Incorporation or design of formative assessment	3.4	1	3	25	26
Integration of computer-based visualizations and images	3.5	0	5	16	35
Integration of online resources and tools (other than images and graphics)	3.4	1	7	16	32
Greater understanding of Earth science content	3.3	2	9	17	28
Instructional effectiveness in general	3.5	1	2	20	32

Means Rating and Frequencies
Field Test: N = 61
Missing: 6

Survey Section 4: Student Experience

Table D-20. Teachers' Ratings of Level of Student Engagement During ESBD Unit

Please rate the level of engagement displayed by your students during your ESBD unit.	Mean	Frequency
Students did not appear to be engaged	3.53	0
Students appeared to be somewhat engaged		1
Students appeared to be engaged		24
Students appeared to be very engaged		30

Mean and Frequencies
Field Test: N = 61
Missing: 6

Table D-21. Teachers' Ratings of Unit Effectiveness

Please rate the effectiveness of your ESBD unit in promoting student learning compared with other ways you have covered the same or similar content to that addressed in your ESBD unit.	Mean	Frequency
Not as effective	3.32	1
Moderately more effective		8
More effective		22
Much more effective		22
Not applicable		3

Mean and Frequencies
Field Test: N = 61
Missing: 5

Survey Section 5: Peer Observation

Table D-22. Teachers' Ratings of Own Preparedness for Observation

Please rate the extent to which you felt prepared to observe your partner's ESBD unit implementation.	Mean	Frequency
Not at all prepared	2.4	6
Moderately prepared		10
Prepared		7
Very well prepared		5

Mean and Frequencies
Field Test: N = 61
Missing: 33

Table D-23. Teachers' Ratings of Comfort Level in Providing Feedback

Please rate the extent to which you felt comfortable giving feedback to your partner about your observations.	Mean	Frequency
Not at all comfortable	3.1	3
Moderately comfortable		3
Comfortable		6
Very comfortable		10

Mean and Frequencies
Field Test: N = 61
Missing: 39

Table D-24. Teachers' Ratings of Partners' Preparedness for Observation

Please rate the extent to which your partner seemed prepared to observe your ESBD unit implementation.	Mean	Frequency
Not at all prepared	2.9	2
Moderately prepared		6
Prepared		10
Very well prepared		7

Mean and Frequencies
Field Test: N = 61
Missing: 36

Table D-25. Teachers' Ratings of Comfort Level in Being Observed

Please rate the extent to which you felt comfortable being observed by your partner.	Mean	Frequency
Not at all comfortable	3.4	0
Moderately comfortable		4
Comfortable		8
Very comfortable		13

Mean and Frequencies
Field Test: N = 61
Missing: 36

Table D-26. Teachers' Ratings of Usefulness of Feedback Received

Please rate the usefulness of the feedback you received from your partner.	Mean	Frequency
Not very useful	3.0	2
Moderately useful		4
Useful		13
Very useful		7

Mean and Frequencies
Field Test: N = 61
Missing: 35