NASA Explorer Schools
Evaluation Brief 3

A Program in the Making: Findings from Year 1

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NASA-Sponsored Classroom of the Future

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Table of Contents

NES Evaluation Brief 3: A Program in the Making

Findings from Year 1

Executive Summary

In 2003 the NASA Explorer School (NES) program was launched nationally with the participation of 50 school teams. Designed as a three-year partnership with schools, the goal of the NES program is to help middle schools improve teaching and learning in science, technology, engineering, and math through significant structural (e.g., professional development, stipends) and curricular supports based on NASA's resources. The research and evaluation team of the Classroom of the Future is conducting the evaluation of the NES program. The goal of the evaluation is to document the design decisions that NASA and participating schools make throughout the program as well as the impact of those design decisions on the program objectives. This brief provides an update on program progress at the end of Year 1 of the program.

The analysis of available data confirmed the program is serving underserved schools, teachers, and students targeted in the program design, and it is also providing comprehensive supports including access to educational resources and professional development assistance. Evaluation results also suggested that participating school teams are trying different ways to organize themselves and to develop strategic and implementation plans. Given the complexity and magnitude of the program, it was evident that both school teams and program staff realized that long-term improvements and large-scale organized supports are not easy to implement. The coherence of program implementation, in general, proved challenging and can be improved to help school teams organize themselves and in terms of the total design for professional development supports. Overall, participants appreciated the opportunity to participate in the program and provided positive feedback on the program as a whole.

A series of lessons emerged from the summative analysis in four key areas related to: (a) developing shared understandings for participation; (b) helping school teams establish coherent connections to curriculum, teaching, and learning; (c) emphasizing school structures and conditions supportive of interdisciplinary team collaboration; and (d) seeking external supports for coherent professional development and enhanced community/family involvement. These emerging lessons were identified in the context of initial evaluation work focusing on the nature and quality of program components to be conducted in the first two years of the program.

All in all, the NES program appears to be well positioned in helping school teams meet their goals. Major findings and lessons learned in the evaluation of Year 1 should be helpful in informing further design and implementation decisions in the program, and to make it better as a second cohort joins the program in 2004.

Background

In 2003, the NES program began with a cohort of 50 middle school-based teams from around the nation. The selected school teams are located in urban, suburban, and rural areas with substantial representation of traditionally underserved students. Under a three-year partnership with school teams, NASA launched an ambitious undertaking to help middle schools improve student learning and interest in science, technology, mathematics, and geography. To fulfill this commitment, the NES program designed and organized sustained professional development supports made available throughout the school year. Ultimately, through organized access to NASA educational resources and professional development supports, the NES program seeks to help school teams increase:

1. Student ability to apply science, mathematics, technology concepts.
2. Student knowledge about careers in science, mathematics, and technology.
3. Student interest in and participation in science, mathematics, and technology.
4. Active participation and professional growth of educators in science, mathematics, and technology.
5. Family involvement in student learning.
6. Academic assistance for and technology use by educators in schools with high populations of underserved students.

In turn, each of the 50 school teams developed strategic and implementation plans to organize internally, and take advantage of both local and NASA resources to address the NES program objectives. A review of the top school teams' priorities related to science, mathematics, geography, and educational technology indicated a close alignment with the spirit of the NES objectives and with NASA's core resources (Hernandez, McGee, Kirby, Reese, & Martin, 2004).

Program Activities in 2003-2004

At the core of the program, and as part of the commitment to support school teams, NES offered a series of professional development activities and special events during the year. The common denominator of NES professional development activities was a focus on NASA content at the 5th to 8th grade level, learning about strategies for curriculum integration, and opportunities to interact with NASA scientists.

Summer Workshops

In July 2003, the NES program was inaugurated via one-week summer workshops offered by field centers to their affiliated school teams. The summer workshops served as the launching pad to introduce school teams to the wide array of educational resources available through NASA. The workshops also represented an opportunity for teams to develop an internal rapport with team members and externally with field center staff, think about implementation strategies, and about follow up professional development needs. For field center staff, the summer workshops initiated a new way of thinking about professional development, and about design decisions to better support school teams.

Strategic/Implementation Planning
School teams in Year 1 of the program produced three important documents. In the first document, the 3-year strategic plan, teams outlined their goals in the context of current student performance, the relation to the NES objectives, and related needs for improvement. In the second document, the 3-year implementation plan, the teams indicated activities to be conducted and professional development to be completed as means to accomplish their goals. The third document, the technology plan, outlined anticipated plans for using technology during participation in the program. Plans were submitted to NASA in October 2003 as a requirement for disbursement of grant funds. These documents provided the basis for designing NES programmatic and professional development supports.

On-site Professional Development Support
A key design feature of the NES program is the commitment to provide direct and sustained on-site professional support to school teams. This is accomplished by organizing regional clusters of school teams around NASA field centers located in different regions of the nation. Under this design, each field center served five school teams in Year 1. Outreach staff from the Aerospace Education Services Program (AESP), provided assistance and follow up supports to school teams depending upon availability and needs. AESP specialists have broad content knowledge of NASA educational resources and curriculum materials. AESP specialists would conduct demonstrations to students and/or teachers, or broker the participation of a NASA scientist in on-site activities.

NES Institutes
In fall 2003, school teams had the opportunity to attend institutes of their choice based on their interests and needs. In winter and spring 2004, a series of special events were also available for school teams. Fall institutes were organized around the meetings of the National Science Teachers Association (NSTA) and the National Council of the Teachers of Mathematics (NCTM). In some cases, NES receptions were organized as a means to create program awareness and disseminate program information among key target audiences (e.g., school administrators).

NES Special Events
Beginning in the winter, a series of special NES events were offered to school teams as complementary professional development opportunities. These special events were designed for teachers to study a topic in depth through inquiry-based professional development activities. Given the specific content (e.g., effects of microgravity), only teams that could conduct related activities with students were eligible to participate. In addition, NASA dignitaries conducted site visits to participating schools as a means for demonstrating NASA's commitment to supporting local efforts and boost support for school teams. Finally, a student symposium was held in May 2004 to feature student activities stemming from teacher work resulting from participation in the NES program.

The NES professional development activities and special events, along with the strategic and implementation plans, provided the means for documentation of design and organizational decisions. They also allowed for documentation of quality of professional development supports and program participation.

Evaluation Brief 3: Scope and Purpose

During the first year, both NES program staff and school teams experienced many design decisions to maximize participation in the program. A mid-year review of the program indicated that the NES program was well positioned in meeting the criteria of high-quality professional development both in terms of structural and core features. However, more evidence was needed to support the quality of these features (Hernandez, et al., 2004).

In the context of the total evaluation design, the plan is to document the key components of the NES program as an intervention during the first two years, and begin collecting comparative data in Year 3 to gauge impact on student achievement. Under this timeline, the purpose of Evaluation Brief 3 is to summarize data available at the end of Year 1 of the program. The focus of the Brief is to present evaluation results based primarily on feedback provided by school teams (2003 cohort) and field center staff. The goal is to document how the program worked and determine initial impact at the teacher and school level. To this end, this Brief describes how school teams organized themselves to participate in the program, how and to what extent field centers supported school teams, and what was the nature of impact at the end of Year 1.

Program Supports: A Matter of Coherence

At the core of the NES professional development supports is the issue of coherence. Is the school teams' strategic and implementation planning aligned with curricular needs? Do professional development activities available to school teams directly support what the teams need in terms of content, teaching strategies, and resources? Overall, does the collective work of both school teams and field centers support the NES objectives?

Making teachers aware of the wide array of NASA's educational resources is not enough. There has to be explicit goals for improvement of teaching and learning, specific supporting connections to the school's curriculum, and direct relevancy to professional development needs (Hiebert, 1999; Newmann & Associates, 1996). The key issue for professional development programs is to establish explicit and relevant connections between program activities. Based on a large study of professional development effectiveness (Garet, Porter, Desimone, Birman, & Suk Yoon, 2001), a professional development program: "is more likely to be effective in improving teachers' knowledge and skills if it forms a coherent part of a wider set of opportunities for teacher learning and development." (p. 927)

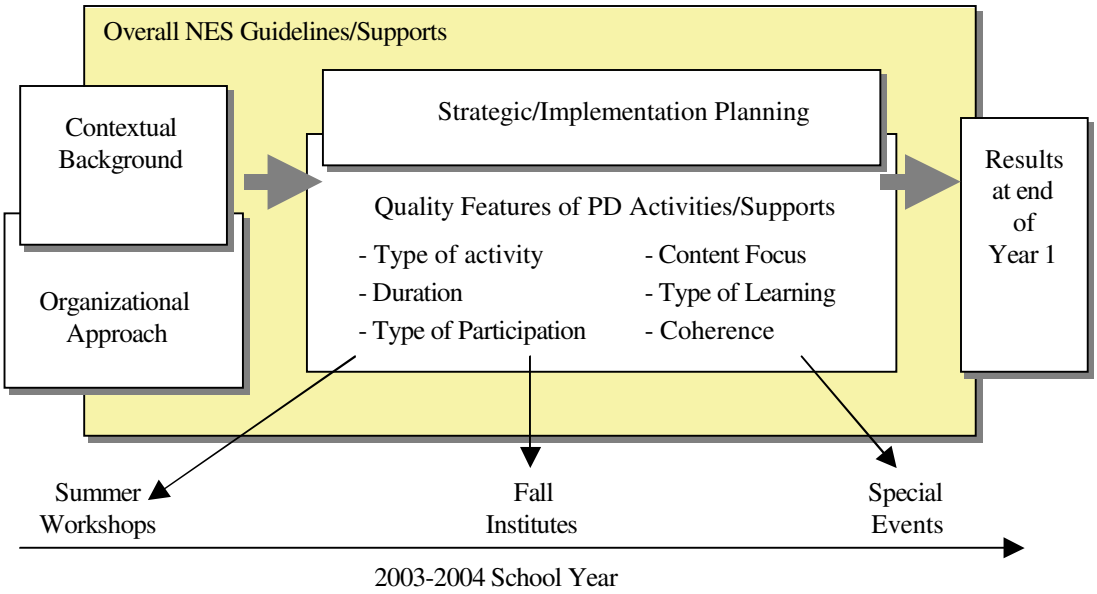
In this context, we assessed the coherence of teachers' professional development in four ways: the extent to which it builds on perceived needs (contextual background); the alignment with strategic/implementation planning; the nature of direct professional development supports provided by field centers; and the nature of overall program guidelines/supports emphasized by NASA headquarters.

A Logic Model of Program Supports

Figure 1 shows a logic model of NES program supports and the expected interconnections. The contextual background positions the school teams in areas of perceived needs their collective work is supposed to address. It also provides an idea of inherent constraints related to the community, students, and school historical development (e.g., budget cuts, teacher turnover). Based on this contextual

background, the expectation is that school teams would organize themselves in strategic ways to account for contextual factors. For example, whereas a team may not require the active participation of an administrator, for another team this participation would be essential. In other cases, teaming up with elementary and/or high school partners would account for transitional problems and sustained student interest in math and science.

Figure 1. Logic Model of NES Program Supports and Evaluation Targets



A second layer of "fit" is connected to strategic/implementation planning. This dimension of participation is critical in guiding the participation of school teams and helping field centers provide effective support. What were the expectations of school teams upon enrollment in the program? What strategies did the teams used to produce strategic/implementation plans? What were the top priorities across the board? What did they plan to meet their needs? Responses to these questions provide indicators of alignment with school needs, and relevancy of proposed course of action including professional development needs.

A third layer of support reviewed for coherence is the area of direct professional development supports provided by field centers. This is the area where a stronger link to meeting school teams' professional development needs was expected. Tangible contact and support was provided in the form of a summer workshop, and numerous institutes and special events. Collectively, what was the perceived value of these activities? What was the quality of the professional development features? Since these professional development activities and supports were complemented with a program of follow up assistance on site, it is important to assess the extent to which the professional development component of the program met the needs of the participants.

Finally, the fourth layer of support relates to the overall NES program guidance and supports provided and/or emphasized by NASA headquarters. The executive team represents a collaborative effort with staff from the National Science Teachers Association (NSTA). NSTA staff facilitates communication with field centers and school teams, promotes activities deemed important, and enforces compliance with the terms of participation. How did school teams perceive this layer of support? To what extent did this program structure facilitate the work of field centers and school teams? These important questions were useful in guiding the collection and analysis of relevant data.

This model allows for an assessment of the program in two ways. Whether participation in the program is characterized by coherent approaches and practices, and the extent to which professional development and support structures are meeting the needs of the school teams.

Evaluation Approach

The design of the overall evaluation includes two major components. First, we follow a design experiment focusing on how the schools are participating in the program, and how NASA is supporting the schools. Design experiments involve a process for documenting design decisions and using evaluation information to inform design decisions (Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Shauble, 2003). Second, we combine the design experiment methodology with a scientific-based research (SBR) methodology to establish comparisons over time using a control group to measure the effectiveness of the program. Brief 1 provides a description of the overall evaluation design (McGee, Hernandez, & Kirby, 2003).

Program Implementation: Review of Year 1

In the context of the design experiment approach to evaluation, a mid-year review was conducted to document and describe baseline trends with primary focus on summer 2003 workshop experiences. The results of this mid-year review are presented in Brief 2 of this series (Hernandez, et al., 2004).

This NES Evaluation Brief 3 focuses on the program implementation in Year 1 drawing from the perspectives of both school teams and staff from field centers. The goal was to document and describe the contextual and organizational background of school teams, their approach to strategic and implementation planning, and perspectives on summer workshops. By establishing connections to design decisions and quality features of professional development, the evaluation of Year 1 program implementation allowed us to:

- Provide a summative picture of Year 1 (e.g., how things worked)
- Identify evidence of conditions and factors affecting decisions from the perspectives of contributing parties (i.e., school teams, field center staff)
- Gauge the coherence of school teams' plans, NES program objectives, and professional development supports
- Generate lessons learned to inform further design decisions on organizational and professional development features

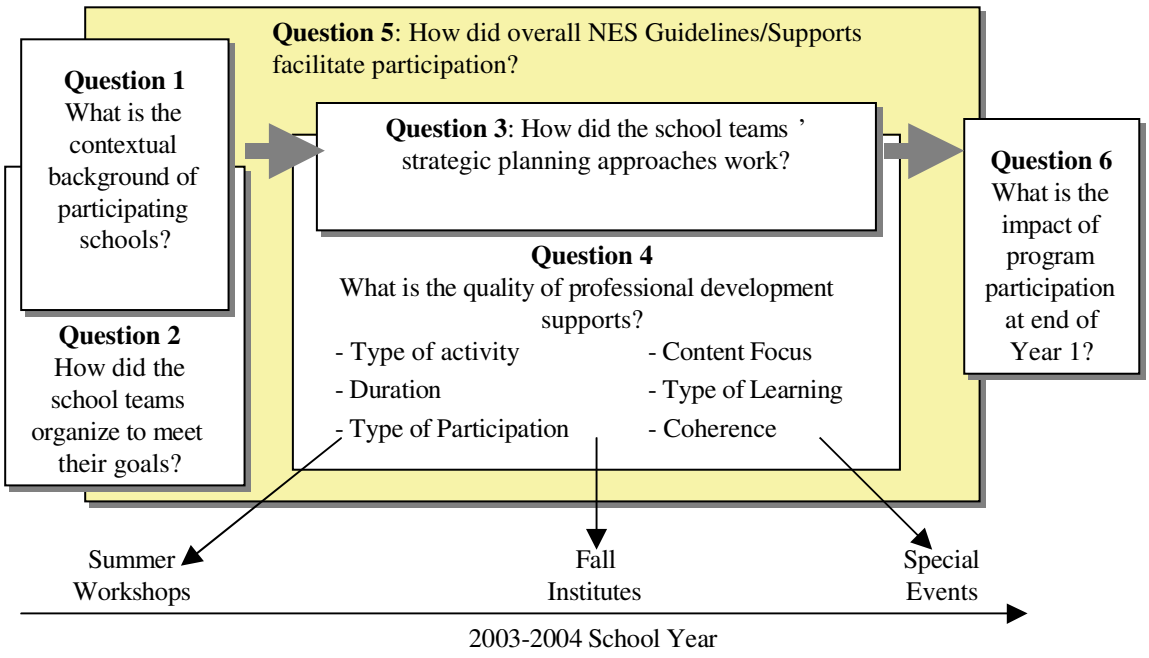
As a second cohort joins the collective journey in 2004, we sought to describe how the program worked in Year 1 and produce a summative account to inform subsequent design decisions of this program in the making.

Guiding Evaluation Questions

Six questions guided the evaluation of the program implementation in Year 1 (from summer 2003 to spring 2004). The questions were intended to address the issue of coherence in terms of participation in the program, and supports provided to school teams. The evaluation questions are presented below, and Figure 2 shows how they guided the inquiry in the context of the logic model for NES program supports.

1. What is the contextual background/conditions of participating schools?
2. How did the school teams organize to meet their goals?
3. How did school teams' strategic planning approaches work?
4. What is the quality of professional development supports?
5. How did overall NES program guidelines/supports facilitate participation?
6. What is the impact of program participation at end of Year 1?

Figure 2. Alignment of Logic Model of NES Program Supports and Evaluation Questions



In Brief 2, we summarized demographic data describing the overall pool of selected school teams. This included information about geographical distribution, urbanicity level, teacher variables (e.g., gender, ethnicity, subjects taught), and about the

student population (e.g., ethnicity, participation in reduced lunch). In this Brief, Question 1 allowed us to follow up with teacher insights about school and student factors underlying program participation and goal identification. Concurrently, in the previous Brief, we also identified the top targeted priorities of school teams in terms of academic standards. For the review of Year 1, Question 2 addresses the type of approach the teams followed to organize themselves for effective participation in the program (i.e., meet their top targeted academic priorities).

In addition to organizational approaches, we were also interested in determining the type of strategic planning and related implementation activities anticipated and completed to support team participation (Question 3). In turn, we sought to determine how the school teams were supported by the field centers (Question 4). In summer 2003, school teams attended a professional development workshop at one of the 10 NASA field centers. Each center designed and delivered a one-week workshop for the five school teams selected from its service area. The nature of the summer workshops and related evaluation is presented in Brief 2 (Hernandez, et al., 2004). In this Brief, Question 4 focuses on how both school teams and field center staff viewed the workshops and subsequent professional development supports. Question 5 extends related inquiry to an assessment of the role of NES guidelines/supports in facilitating participation in the program.

Finally, Question 6 drives the analysis of initial impact on schools and teachers stemming from data related to Questions 1-5. In particular, we examined changes in collective perspectives and beliefs on teaching, learning, and technology to set the baseline context for future reference and analyses. Drawing from a summative analysis, we identified "lessons learned" and implications for future design decisions in program implementation in the context of enhanced coherence.

Data Collection/Sources

Data collection was collected from seven primary sources of information including: (a) survey of academic priorities, (b) focus groups with school teams, (c) strategic and implementation plans, (d) focus groups with staff from field centers, (e) technical needs assessment survey, (f) NASA Educational Evaluation Information System (NEEIS) data, and (g) teaching, learning, and computing survey data.

Survey of Academic Priorities

Upon enrollment in the program, selected teams were asked to complete a survey of top academic priorities. The purpose of this survey was to identify areas of interest and use resulting data to inform decisions for designing and implementing summer workshops and other supports. The survey asked participants to identify and rank academic priorities for science, mathematics, geography, and technology using national standards as a frame of reference.

Focus Groups with School Teams

We also developed a protocol for conducting focus groups with school teams to capture the participants' perspectives aligned with evaluation questions. The protocol included questions about initial expectations, evaluative perspectives of summer workshop experiences, process for developing strategic and implementation plans, interactions with NASA field centers, satisfaction with supports, and suggestions for program improvement. To this end, we took advantage of participation in institutes and special events available to school team members during the academic year. A total of 20 focus groups representing 19 school teams were conducted. This

represented 38 percent of all school teams in the program. Together, school teams participating in focus groups represented affiliation with a total of eight field centers.

Strategic and Implementation Plans
School teams produced two important documents in Year 1: Strategic Plans and Implementation plans. These documents served as the primary means for documenting what school teams were intending to accomplish and how they were planning to meet their goals. The technology plan was primarily used to inform field centers of immediate ideas for use and related needs, and was not part of the analysis at this time.

Focus Groups with Field Center Staff
Focus groups were also conducted with field center staff including AESP specialists from each field center to gather their insights about school teams, professional development supports, and overall NES guidance/supports. The interview protocol we developed for this purpose included questions paralleling those asked to school teams to triangulate sources. In fall 2003, all focus groups were completed at a field center staff retreat held at the Center for Educational Technologies in Wheeling, WV. Updates and follow up insights were gathered through note taking at monthly telephone conferences including NES executive staff and field center staff, and electronic correspondence during the year. This information allowed us to gather additional insights on the nature and extent of school supports and how the program organized resources, events, and personnel to support school teams.

Technical Needs Assessment Survey
Given the fact that a large proportion of NASA educational resources are based on instructional technology (e.g., multimedia programs, simulations, web-based programs), and due to the need for electronic networking, it was essential for the program to determine technological capabilities at each participating school. A technical needs assessment survey was developed and administered by the University of Texas at El Paso. NES schools with the help of a technology coordinator or network administrator completed the survey. The purpose of the survey was to get baseline information about the technical infrastructure of the school to assist in the planning phases of a videoconference initiative.

NEEIS Data
As a standard procedure, all participants in NASA-sponsored events are required to complete an evaluation form at the end of the organized activity. Such evaluation forms are part of the NASA Educational Evaluation Information System (NEEIS). Consequently, at the end of the 2003 summer workshops, all participants were required to complete a NEEIS evaluation form, which required feedback on demographic information, value and benefits of participation, and satisfaction with a variety of workshop factors (e.g., content, organization). Likewise, school teams or individual members participating in fall institutes and/or special events held in Year 1, had to complete a NEEIS evaluation form if the event was held at a NASA affiliated location.

Teaching, Learning, and Computing Survey
All participants in the 2003 Cohort were required to complete a modified version of the Teaching, Learning, and Computing (TLC) survey (Becker, 2000). The TLC is a self-report questionnaire that measures teaching practice, teaching beliefs, technology use in the classroom, and teacher professionalism. The original version

was used in a national survey that included 4,100 teachers. Four different versions of the survey were used in the national study with some overlapping items. Information about the validity of the survey is provided elsewhere (see Becker & Anderson, 1998). In this evaluation, four versions of the TLC were combined into one questionnaire, taking less than 60 minutes to complete online. The final TLC questionnaire consists of five constructs: technical skill (TS), constructivist teaching strategies (CTS), attitude toward technology (ATT), constructivist teaching philosophy (CTP), and constructivist uses of technology (CUT). Participants completed the TLC survey at the beginning and at the end of Year 1.

Analysis

Descriptive and comparative analyses were used to summarize data for this report. Qualitative data resulting from focus groups were analyzed using the software program NVivo (2002). The software is based on a program for non-numerical unstructured data indexing searching and theorizing that allows for thematic analyses based on coding of variables of interest. In our analysis, we coded for major themes including contextual background, organizational approach, strategic/implementation planning, professional development supports, and overall program supports. Within these major themes, a number of properties were identified for depth in the analysis. The criteria to support findings were based on frequency and consistency of related insights across teams and field centers. In addition, staff triangulated various sources of data to validate emerging findings.

Strategic and implementation plans were analyzed using a descriptive analytical approach to create numerical indicators (e.g., percentage of school teams focusing on particular common goals). The text of these documents was also analyzed using the NVivo analytical software to identify common themes in the data and add richness to numerical indicators. A finding was determined by at least four related comments found in at least three different field centers. Concurrently, the analysis of the technical needs assessment survey was conducted using basic descriptive statistics. Indicators of established technical capacity were reported using relative frequencies.

For the analysis of professional development supports, qualitative data from focus groups with school teams and field center staff were coded using variables aligned with a framework for effective professional development (Garet, Porter, Desimone, Birman, & Suk Yoon, 2001). The key features of this framework include the following:

- Type of Organized Activity. Whether professional development activities focused on traditional (e.g., participants attend sessions at scheduled times) or reform type of approaches such as study groups (e.g., focused and sustained work that may happen anytime during the school year)

- Content Focus. Whether the focus was on subject matter content, teaching practices, and/or nature of student learning. Of particular interest was the extent of emphasis on inquiry-based teaching and learning and integration of NASA resources into teaching and learning activities.

- Duration of the Activity. Whether the professional development activities are sustained over time or are short and terminal with no follow-up. Longer and

extended activities afford in-depth discussions of content and pedagogical strategies.

- Type of Learning Activity. Whether participants had opportunities to practice and/or reflect under simulated conditions, receive feedback, met formally and/or informally with others to discuss classroom implementation, develop curricula or lesson plans, review student work, and/or to present or lead discussions.

- Type of Participation. Whether the activities were designed for a group of teachers from the same school or grade level, or for individual teachers from different schools or grade levels. Teachers who work together are more likely to discuss concepts, skills, and problems that arise during professional development experiences.

- Coherence with Other Learning Activities. Whether professional development activities built upon ongoing teacher/school efforts, align with academic standards, and have potential for sustaining and extending what is learned to other teachers.

Impact of participation was determined in terms of evidence of use of resources and implementation activities in schools. We also focused on initial impact on teacher collaboration and the extent to which professional development supports and team efforts aligned to support a coherent program of teacher learning and development. Impact was also documented through an analysis of changes in scores on the TLC survey. The five constructs underlying the TLC (technical skills, constructivist teaching strategies, attitudes toward technology, constructivist teaching philosophy, constructivist uses of technology), included clusters of items representing each construct. Item responses were grouped and standardized to generate a participant score for each construct. T-tests were used to determine differences between pre and post scores.

Findings

Evaluation findings are presented in six sections each addressing a guiding evaluation question. First, we describe important contextual conditions underlying the work of participating school teams. Next, we present a summary of organizational approaches followed by school teams. Third, we describe the processes for developing strategic/implementation plans. This is followed by a description of perspectives on the nature and value of professional development supports provided by field centers and overall guidelines/supports provided by the NES program. Finally, we discuss the impact of participation at both the school and individual level.

What is the contextual background of participating schools?

To meet the program objective related to serving schools with high populations of underserved students, the program followed a targeted selection. As a result, 58 percent of the participating school teams can be identified as working in high-poverty communities. In general, a school is considered to be located in a high poverty area if at least 35 percent of its students come from low-income families. Low-income status is defined by whether or not students are eligible for free or reduced lunches (Brown, 2003).

Collectively, the 50 school teams selected for participation in the NES program represent 30 states and 61 schools involving a total of 250 educators (i.e., teachers and administrators) and 36,082 students. Table 1 presents the ethnic background of students in NES schools by type of community.

Table 1. Ethnic background (in percentages) of students in rural, suburban, and urban NES schools

Ethnicity	Rural	Suburban	Urban	Overall
Caucasian	50.0	37.0	28.8	36
African American	21.8	43.4	44.5	38
Hispanic	9.9	18.0	22.0	18
Asian/Pacific Islander	11.9	1.4	4.0	6
Native American	5.7	0.2	0.7	2
Total	26.7 (9,629)	10.6 (3,832)	62.7 (22,621)	100 (36,082)

Students of Caucasian and African American descent are represented at comparable proportions (36 and 38%, respectively), but with contrasting distribution across types of community. Representation of Hispanic students is relatively robust at 18 percent, while Asian/Pacific Islanders and Native Americans are represented in lower numbers (6 and 2%, respectively). The majority of the students are found in urban communities (62.7%), followed by students in rural settings (26.7%). The rest of the students attend schools in suburban communities (10.6%).

Perspectives on School/Community Context

The issue of poverty and the interplay with school culture was voiced by more than half of school teams (55%) who participated in focus groups. In some instances they spoke of the dire living conditions in the community: "Many of the children [in our school] come from homes with no running water or heat." In other cases, they talked about the bleak prospects for students because of the lack of skills and incentives to perform well in school. For example, one teacher expects about a third of the middle school class to drop out "because of the lack of skills," and hopes that this can be overcome by getting students interested early in science, math, and technology. The community context of a school team in a tribal community shown in Box 1, is an example of related challenges:

Box 1. Community/school indicators in a tribal school district

The Solen-Cannon Ball School District consists of two public schools, Cannon Ball Elementary School (K-6) and Solen High School (7-12), located in rural Solen, North Dakota. The School District is made up of 173 Native American students for grades K-12. In 2000, the federal government identified both schools as Title 1 schools "in need of improvement." According to the 2000 U.S. Census, the average household income was $22,483 and 39.2% of the population was below the poverty level. In the schools, 65% of the students receive free or reduced price lunches. Further, North Dakota uses the Comprehensive Test of Basic Skills (CTBS) to test students in grades 4, 6, 8, and 10. The CTBS is a norm-referenced test, which measures how well students in North Dakota score in comparison to a national sample of students. The 50th percentile is the national average. Students in grades 4 and 6 at Cannon Ball Elementary scored in the 30th to 40th percentile rank in language arts, math, and reading. Students in grades 8 and 10 at Solen High School scored in the 8th to 20th percentile ranks for language arts, math, and reading.

Further, some teachers clearly articulated the potential benefits of program participation for schools operating in low-income communities, in particular, in these times of increased pressure for accountability. Combined with budget reductions everywhere, schools have to make hard choices and schools in poor areas that are affected the

most, may have the potential to benefit greatly from participation in the NES program.

In response to this issue, the NES program made a concerted effort to select school teams representing a cross section of types of communities based on level of urbanicity (see Table 1). To this end, in 62 percent of the NES participating schools the typical annual enrollment is represented by a majority of minority students. African American students are the majority in 13 schools; Hispanics represent the largest group in 7 schools, while Asian/Pacific Islander and Native Americans constitute the majority in 2 and 3 schools, respectively. Box 2 shows two examples of school contexts in communities where the majority of students represent a minority group.

Box 2. indicators of communities with predominant population of minority students

Predominantly Hispanic Community: Shirley Avenue Elementary School is located in Reseda, California and is part of the L.A. County School District. Hispanic students comprise 79% of the student population. Spanish is the primary language spoken within the home for 91% of the students, and many of the students do not speak English fluently. Subsequently, 56% of the students are acquiring English skills. According to the 2000 Census Bureau, the median income for Los Angeles County is $42,189 with 17.9% of the population below the poverty level. According to the 2003 California Standards Test, 38% of the students scored at the proficient level or above on the English Language Arts section (state average is 35%). For the Mathematics section, 58% of the students scored at the proficient level or above, compared to the state average of 41%.

Predominantly African-American Comunity: Bunche Middle School is a predominately African American public school located in Atlanta, GA. It is a Title 1 school "in need of improvement." Within Bunche Middle School, 78% of the students receive free or reduced price lunches. In 2002, grades 6-8 fell below average for reading, English language arts, and mathematics on the Criterion-Referenced Competency Test (CRCT) required by Georgia's state educational standards. The 2000 Census Bureau indicates the median household income for the area is $47,321 and approximately 15.7% of the population falls below the poverty level.

In general, the NES program appears to be clearly positioned to serve the type of schools that can benefit greatly from targeted professional development and access to NASA's educational resources. A common perspective among participants is that participating schools are located in "often forgotten areas" that are economically depressed.

Technology Infrastructure

A total of 47 schools completed the technical needs assessment survey. The percentage of school reporting access to specific equipment is shown in Table 2. As anticipated, standard equipment is most prevalent across schools (overhead projector, television, and VCR (range = 90-92%). This is followed by access to other audiovisual equipment including LCD projectors, digital still camera, CD players, speakers, and microphones (range = 73-86%). More expensive and/or specialized equipment such as DVD players, digital video cameras, slide projectors, and analog video cameras are available for half or more of the schools (range = 49-69%). Not surprisingly, only 27 percent of the schools have access to microscope video cameras.

Technical support at the district level is available at 69 percent of the schools, while onsite technical support drops to only 31 percent of the schools. Concurrently, 80 percent of the schools have a district URL, and slightly more than half (55%) have a school URL. Further, only 8.5% of schools had IP videoconferencing equipment. Since videoconferencing capability is a critical requirement for participation in the program, it was arranged with Channel 1 to donate such equipment to schools that did not have it contingent on completing this survey.

Table 2. Percentage of school teams with established technology capacity (equipment)	
Overhead projector	92
Television	90
VCR	90
LCD projector	86
Digital still camera	80
CD player	78
Speakers	78
Microphone	73
DVD	69
Digital video cameras	59
Slide projector	55
Video cameras, analog	49
Microscope video camera	27

Collectively, these results suggest limited access to technology and related supports. They also confirm the challenges brought about by operating in low-income communities, and the need for enhancing existing technological capacity to have full access to technology-based products and activities. This situation also presents a challenge for the NES program in terms of networking and establishing dynamic communication channels via the Internet.

How did the school teams organize to meet their goals?

Even when the intentions are good, high motivation alone does not ensure productive participation in professional development activities. This is particularly true when teachers participate in teams driven by goals that may ultimately have school wide implications (Hernandez & Brendefur, 2003; Kruse, Seashore, & Bryk, 1994). School teams, in particular, constitute a powerful approach to foster the development of professional community and ensure a positive impact of professional development. To promote professional community through interdisciplinary teacher-teams, related literature has suggested the need for shared sense of expectations and values, team development strategies, and organizational strategies based on school and community supports (Hernandez & Brendefur, 2003; Hord, 1997; Kruse, Seashore, & Bryk, 1994). In this section we summarize perspectives on expectations upon enrollment in the program, organizational issues, and support strategies to ensure the development of professional community.

Expectations

A shared sense of expectations is often viewed as the cornerstone of effective participation in long-term participation in professional development activities and related efforts to improve school performance. This is an important issue that emerged across 65 percent of the interviewed teams.

When the 2003 cohort of educators applied to the NES program or joined their NES team, they held expectations at two levels: for the NES program as a whole, and for use of and/or access to NASA/NES resources.

Overall Program Participation. Twenty-five percent of NES schools interviewed agreed that, upon enrollment, participants did not have a full understanding of what NASA can offer to support schools. In general, participants recognized the potential benefits for participation but did not have a good understanding of the scope of supports. One thing was clear though: Given NASA's established reputation as the premier agency in aeronautics and space research and exploration, school teams appreciated the association with NASA. The comment below summarizes this perspective.

> *I knew NASA would give us something great, but I didn't know the extent of how it would help us in the schools. I didn't know if that would mean a lot of NASA people coming into the schools or technology. The reputation of NASA preceded [the program], and you obviously wanted that connection.*

To this end, participation in the summer workshop appeared to be helpful for school teams. The workshop allowed them to develop a better understanding of NASA's role in education, and the vast array of educational materials and resources available for schools and teachers. After the workshop, school teams were in a better position to gauge the full potential benefits for participation in the program. As one participant put it, the workshop provided participants with:

> *…an insider's view of NASA that teachers could take back into the classroom and share with the students. Otherwise, teachers would not have known how they could integrate some of their current programs with NASA resources.*

Access to NASA Educational Resources. Upon enrollment in the program, school teams quickly realized that they only had cursory knowledge of NASA's educational resources. A persistent comment across school teams was the notion of being overwhelmed by the vast amount of potential resources available through the program. Initially, without a full understanding of the nature and scope of NASA resources, school teams had difficulty aligning school goals and specific NASA resources. In turn, it was difficult for school team members to have clear and shared expectations about their participation in the program. To address this issue, school teams suggested providing them information about NASA prior to attending workshops. In their view, an initial understanding of NASA's core goals would have been useful, because "most people only know about the shuttle."

Half of the school teams, however, had specific expectations upon enrollment in the NES program. The expectations fell into the general categories of accessing resources, visiting space centers, sharing NASA resources with others in the school, accessing technology, facilitating family involvement, enhancing professional development, and improving the curriculum. Across school teams, 25 percent specifically mentioned an expectation for the opportunity to "get resources to use in the classroom." Some mentioned the connection to limited access to resources available in rural areas, and that "NASA resources would be a great opportunity to get such resources." One educator explained specific expectations for use of NASA resources and supports:

> *My expectation for infusion of opportunity and support includes both professional development and infusion of hardware and software to*

support the curriculum. With program resources, I see the ability to be able to take children to places never been before.

Organizational Strategies

The decisions and actions that teams make to organize themselves may facilitate or hinder their ability to sustaining productive participation in reform-type professional development activities. Team membership, organizational strategies, and organizational supports are three areas that were mentioned consistently across school teams who participated in focus groups.

Team Membership. In compliance with program guidelines, the typical school team includes an administrator (e.g., principal, assistant principal) whose anticipated role was to empower and facilitate the work of the school team including 3-4 full-time classroom educators.

Overall, a third of all NES participants teach all subjects, while 28 percent teach general science. Teachers specializing in particular areas of instruction (Earth science, life sciences, mathematics, physical science) participate at comparable rates ranging between 15-19 percent. Further, the majority of participants can be characterized as primarily female (72%) and Caucasian (72%), while participants from other ethnic groups accounted for 28 percent of participation (18% African-Americans; 10% Hispanics, Asians, Native-Americans, Pacific Islanders). Also, the majority of participants hold a master's degree (60%), while about a third have a baccalaureate degree.

A typical school team may include resource, content specialist, or other educators as determined by overall team needs. In some cases a school team also includes someone from a local informal education sector, a higher education institution, a parent association, or a local business leader who would partner with the school team. Thirty percent of the interviewed teams mentioned team selection as an important organizational component. The analysis of focus groups data indicated wide variability in approaches to team selection ranging from highly organized approaches to ad hoc procedures. For example, one school discussed an extensive team selection process whereby team members were requested to submit resumes and were selected based on teaching expertise, extent and scope of prior experience, and knowledge of students, staff, and community.

However, in the majority of the cases (87% of the interviewed teams), school teams described the selection process as an issue or as an area that could have been improved in the proposal or at early stages of participation. In some cases, team affinity was a problem (e.g., "The team I'm working with was not my first choice") because members were conveniently selected either by the team leader and/or an administrator. In other cases it was either a lack of interest to participate and/or alienation generated in the selection process. For instance, a team "tried to get all of the science teachers to be on the team, but they did not seem to be interested, so the team leader recruited teachers from other disciplines." Other teams missed opportunities to rethink and/or strengthened membership after attending the summer workshop and realizing the full nature and scope of participation:

Upon return from the workshop I think we should have added math teachers and technology teachers to the team. We would have liked to have brought more teachers to the workshop.

When teachers were brought later to the team for whatever reason (e.g., late selection, replacing members), it was clear they were not as informed about details of participation as early members. In this context, preserving the initial team membership was a priority and in some instances a real challenge due to high turnover. This issue was voiced by 30% of the interviewed teams. In particular, the loss of team members with prior experience in NASA educational activities had added implications for teams whose interest were driven by members no longer in the team. The comments below summarize these issues:

> *That teacher is no longer working at our school. He and another member of the original team moved to a high school after attending the summer workshop.*

> *We want to do the Globe program with video conferencing. Have two Globe kits, but don't know what to do with them because two team members are no longer on the team.*

Organizational Strategies. Some school teams created partnerships between an elementary, middle, or a high school or any relevant combination as a strategy for productive participation based on specific local needs. The challenge for all teams was to preserve the team and to ensure organizational supports for effective participation in the program. Sixty percent of the interviewed school teams discussed the organizational strategies including the role of school administrators, strategies for success, and strategies for team building.

The role of administrator was key in supporting school teams given the issues associated with team membership. In some cases where some degree of resentment and jealousy stemmed from the selection process and what was perceived as elitist participation in the program, the role of the administrators was even more relevant. In other instances there was a perception that there was no support from administrators either at the building ("There is no administrator who had claimed this project as their own") or district level. ("The school district doesn't seem to care") and were begging for administrative leadership. In contrast, schools with greater administrative leadership spoke of support for program implementation within a school-wide community. One success case mentioned that that school's entire NES team was sent to one fall conference (NSTA meeting) because "the vice principal felt it was important for professional development." Another success case provided a more detailed description of the administrator's role:

> *It was important to have an administrator on board, and that the administrator had to go with you to the summer workshop, and that gives vested interest for [him/her] in seeing it be successful. Our principal really backs this and motivates people to participate. Every Monday there is a staff meting for everyone. Three o'clock to five o'clock workshop, and she supplies refreshments.*

The role of the team leader is as important to keep the team together and facilitate productive participation in the program. As some participants put it, the "team leader is overwhelmed. Everything is falling on the team leader." Time demands on the team leader's schedule required some creative organizational arrangements within the team. A librarian, in some cases, was asked to serve as the point of contact to field and process incoming and outgoing communication. Other members were asked

to fulfill other roles to ease time demands on the team leader and the team as a whole.

Organizational Supports. Another key organizational issue was the decision to either wait for NES program supports or proceed with the implementation in some way. Eight of the schools interviewed mentioned that they were or had been waiting for some NES supports. They waited for the starter kit via NSTA, NES equipment, and the NES grant funds. At the time of the fall 2003 focus group interviews, none of the NES teams had received NES funding. Twenty percent of the interviewed teams virtually stood still while they awaited funding disbursement. Their view was that, "once the money comes we can do what we want." For some this was a barrier for implementation:

> *We are at a standstill because we thought that anything in the action plan would be purchased for the school and not much was purchased. We are waiting for the grant money to buy the technology necessary to succeed.*

Other teams were proactive and implemented complementary support strategies to ensure successful implementation of team efforts. Sixty percent of the NES focus group school teams mentioned community as a source of: (a) financial support, (b) support for dissemination through media coverage, (c) support to organize and facilitate a visit from NASA dignitaries in the spring, and (d) general support as a partner in education. Some teams sought business and industry partnerships. For example, some teams established partnerships with area colleges, universities, scientists, and/or museums. One school team sought community support to "raise $11,000 to send 37 at-risk kids to space camp… and changed their lives." In addition, the visit from NASA dignitaries in the spring was viewed as a community event rather than a school restricted function. As a result of participation in the NES program other teams said, "we are in the newspapers all the time."

Community support, however, does not come easy. It is time consuming and requires a high level of commitment to hustle for external supports, especially in areas where these relationships are traditionally weak. Local newspapers are not always supportive of schools, "so it isn't always easy to promote programs." Participation in the NES program, however, appears to leverage support in the community. Kick-off events were a popular strategy to create community awareness about the NES program and sow the seeds for external supports.

How did school teams' strategic planning work?

In this section we summarize the strategic and implementation planning produced by teams to accomplish their goals. The sources of data for related analysis included actual strategic and implementation plans and insights from focus groups.

A total of 40 school-team plans were available for review representing eight field centers overall. Of these, strategic plans were available for all. However, complete sets of both strategic and implementation plans were available from only two clusters of school teams each affiliated with a field center. The overall quality of the strategic and implementation plans varied greatly among school teams. Some of the plans were very detailed and incorporated specific activities that addressed student, teacher, school, and community objectives directly aligned with the NES program. In contrast, other plans contained broad ideas that addressed only a portion of the NES objectives.

Strategic Planning

Specifically, school teams varied in their comprehensiveness of coverage of all the NASA objectives. While all of the teams created plans that adhered to all NES objectives, the specific objectives they focused on, and the means by which they planned to achieve them varied greatly. In this section we summarize goals, strategic supports, and the approach to writing plans.

Goals. Upon enrollment in the program, school teams were asked to identify their top priorities related to science, mathematics, geography, and educational technology. The national science education standards (grades 5-8), the national geography standards, the principles and standards for school mathematics (grades 6-8), and the standards for technological literacy and national educational technology standards served as the basis for identification of top priorities. The top priorities were represented by standards selected as an important focus for school team participation by at least 25 percent of all program participants (Hernandez et al., 2004). Science priorities included three physical science standards (motions and forces, properties and changes of property matters, transfer of energy), two Earth and space science standards (Earth in the solar system, structure of the Earth system), and one life science standard (populations and ecosystems). Geography priorities involved only one standard (the world in spatial terms), while two mathematics priorities were identified as top targets (data analysis and probability). A standard involving design concepts was identified as a top priority on both sources of technological education standards.

In general, top academic priorities are closely aligned with NES academic objectives and NASA's core resources. Collectively, the top academic priorities represent a complementary framework of important science, geography, and mathematics content knowledge; with an emphasis on cognitive processes in applied contexts (e.g., problem solving, design approaches) drawing from mathematics and educational technology.

A review of strategic plans suggested that overall strategic goals were supportive of declared top academic priorities. Overall, school teams targeted objectives trough a wide range of topics (e.g., STEM content interest and application, technology use, problem-based learning and students' role in learning, NES teams' role in dissemination of knowledge, professional development, collaborations, and STEM careers). All in all, across all school teams, there appeared to be a consensus on a hierarchal importance of their goals in relation to the NES objectives. Most school teams concentrated on the following three NES objectives: increasing student interest and participation in science, mathematics, and technology; increasing student ability to apply science, mathematics and technology; and increasing family involvement in student learning.

Based on focus group data, we found that 20 percent of the teams participating in focus groups drafted plans in support of an interdisciplinary approach to math and/or science education following a "project-based approach that integrates all disciplines" and "integrates different subject areas. Learning material to support science in math, family activities, learn science in science classes, reading about the science activities in reading." One team indicated that its strategic plan had the whole school in mind and aligned with the school improvement plan. Under this approach, 100 percent of teachers were on board. In this case NASA promotional materials are disseminated in assemblies, the art teacher is painting Mars murals in the classrooms, and curriculum

resources trickle down to other teachers because the ultimate objective of the team was to promote the development of a learning community.

Further, 20 percent of the interviewed school teams strategically planned support of technology goals "to get our kids more involved in the use of technology and NASA technology resources." For some teams, the goal was to benefit from NES support by bringing technology-enriched education for students to experience uses of technology, as opposed to just talking about it. Other teams further reinforced this idea indicating that the NES program would afford their students the "use of video conferencing equipment to communicate with NOAA and NASA and Globe Scientists," and save the cost of expensive field trips.[1]

Supports. Focus group data showed that NES teams used several support systems necessary in designing strategic plans: (a) scheduled time for group reflection in designing the plan (20% of teams), (b) field center guidance (40% of teams) and feedback (35% of teams), and (c) external assistance in planning and writing (45% of teams). Some field centers helped teams align schools' goals, standards, and NASA resources by providing examples of appropriate NASA resources and showing the connections to both school and NES goals. This support was particularly helpful during the summer workshop as one school team reported:

> *We read and listed and matched appropriate topics during the workshop. They had us look at the state objectives and field center workshop activities, and state framework. Look at what you have done so far. How do the field center activities match state objectives? It was an eye opener. You can accomplish all of these objectives with just these activities.*

Other field centers provided support in the form of feedback through an iterative process of strategic plan revisions. This feedback was appreciated by those who received it and, in cases where no feedback was provided, school teams wished they had received it:

> *We had to rewrite the thing; a whole lot more involved than I anticipated. A lot was more paper work than we believed was possible. Why? Because we couldn't get any feedback in the beginning.*

The quality of feedback was evident when reviewing completed strategic and implementation plans. Entire cluster teams affiliated with particular field centers submitted plans of similar quality hinting field center feedback, while in other cases the quality of plans varied greatly within affiliated field centers. Timely feedback was indeed an important factor in writing strategic plans. Other teams reported that they "came away from the workshop still not entirely sure of their expectations, how they would implement, and what they were evaluated on. There were mixed messages on expectations."

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[1] NOAA stands for National Oceanic and Atmospheric Administration; GLOBE is a world wide hands-on primary and secondary school-based education and service program.

Writing Process. The approach to writing the strategic plan was also an important topic that emerged from focus groups. Forty-five percent of the teams discussed aspects of planning and writing the strategic plan during the summer workshop. Some field centers gave participants time to plan and write strategic plan, while others did not. One of the teams questioned the nature and quality of the activity:

> *During the summer workshop, we didn't spend time working on the action plan. One team did, but they were directed and did it on their own. I don't know what they call action planning on the schedule. The activity we did wasn't sitting down and working on an action plan. I remember just getting an overview on it.*

Participants often mentioned that they found difficult to work effectively when strategic planning sessions were held during the evening due to busy and long day schedule. One team explained:

> *Only had one evening to work on strategic plan. It was late (8 PM) when we got started and they had one person from the field center who could help. Got lots of examples of inquiry based learning, but did not have time to reflect on it. And had no time during the workshop to outline what we wanted to do. Usually, they had things scheduled up until 8 P.M. each night and the day started at 7 A.M. People weren't able to focus when they finally got together to talk.*

"Once back at school, it was difficult to find time for the strategic plan," reported another team. Sixty-five percent of the teams discussed specific work habits used during the process of writing the plan, 50 percent mentioned guidance, 60 percent identified the structure of the individuals or groups who actually wrote the document. Some found "email easier to do than meetings," and electronic communication appeared to be a popular strategy for team interactions and feedback.

In some cases, the team leader involved key stakeholders in the writing process to ensure ownership of the program by the entire school community. For example, one team leader sought input from her principal, staff, and PTA and decided to focus team efforts in the development of a stand-alone unit featuring use of technology to be accessed in the program. The team leader explained her thinking:

> *I am a science resource teacher, so I looked at our curriculum for seven science classes and extrapolated according to local and national standards methods of implementing that process. Then, I built a curriculum matrix. It was an opportunity for me to direct teaching and learning focused and learning on standards aligned with NASA resources based upon NASA themes.*

The same team identified NASA resources to be integrated into the curriculum, and planned to work on two categories by month. To this end, the team leader worked backwards. She first "took ideas from the summer data dump, and then went forward identifying specific NASA resources."

Another strategy used to support the writing process was the use of outside consultants, who became part of the team. A consultant serving in this capacity explained that his role was to help the team "formulate the strategic plan and align it

with standards," and he followed up with continuous feedback before the team submitted the plan. In another case, school teams set up NES advisory boards including NASA employees (engineer, scientist, physicist, payroll dept. employee) and a local committee to help school come up with ideas to reach their goals. One of such teams reported to have had three teleconferences after the summer workshop. In these cases, the team leader talks to the team's NASA advisory board and the local committee.

The actual writing was approached in various ways. In some cases, one or two teachers, an administrator, or the team leader wrote the plan. In other cases, the entire team designed and wrote the plan collaboratively. In general, those teams who felt their planning efforts to be successful mentioned they "took basically NASA things that were put out to us during the workshop and flowed them into" a plan aligned with school goals and national/state standards.

Implementation Plans

In Year 1, all school teams seemed to primarily focus implementation activities on using NASA curriculum products and benefiting from access to technology. Next, about half of the school teams reported an interest in integrating NASA resources into the home in some form of parental activities, and having access to NASA scientists as guest speakers. To a lesser extent, other school teams were thinking about benefiting from web-based resources, student/teacher workshops, and teaching students uses of technology (see Table 3).

Overall, 34 of the school teams mentioned three or more types of implementation activities necessary in achieving their strategic goals. These activities included working cooperatively with other team members (32 teams), focusing on knowledge and utilization of problem and/or inquiry-based learning (32 teams), incorporating student research investigations as a means of achieving objectives (12 teams), and using student projects (11 teams). In general, connections to careers were mentioned by 22 school teams in ways that signaled secondary emphasis either as part of learning activities (e.g., identifying occupational roles) or through use of guest speakers (e.g., use of scientists representing different NASA careers).

Another implementation activity that was mentioned by many of the NES teams was incorporating a special event into their overall plan. For example, 32 school teams anticipated taking advantage of NES special events (e.g., visits of NASA dignitaries), while 27 school teams planned special events of their own including Star Night, NASA night, and other similar themes. Other school teams reported some form of special event (13 teams), or planned to organize clubs related to science, math, engineering, and technology (11 teams). Some of the implementation ideas planned around student involvement included student Inquiry Zone workstations featuring NASA initiatives and integration of NASA curriculum products. One school team, in particular, anticipated student write-ups on their experiences for the local newspapers, and student input in choosing the type of activities and content of interest. Other school teams planned school-wide activities based on technology-based competitions (e.g., Robotics Team, Think Quest, science fairs) available to all students.

Professional development was another significant aspect of the implementation plans. Virtually all of school teams include some type of professional development into their plans. The majority of the teams (70%) anticipated a focus on NES-related professional development, while more than half of the teams (57.5%) planned complementary participation in general professional development activities. Some of the activities specific to the NES program included participation in professional development workshops, seminars, and conferences attended by members of the NES team; and monthly team meetings to discuss professional literature on effective science teaching and integrating technology into the classroom. Only seven school teams mentioned using their AESP specialist to support professional development activities and/or student/school activities.

Table 3. Number of school teams reporting specific implementation activities

Access to technology	40
Using NASA curriculum products	40
Integrating NASA resources into the home	21
Access to NASA guest speakers	20
Use of NASA web-based resources	17
Access to student/teacher workshops	15
Opportunity to teach students uses of technology	12

Connections to parents and community were also an important component of implementation activities. The majority of teams (39 teams) proposed activities leading to targeting family and community connections. For example, some school teams planned to conduct workshops and/or seminars using video-conferencing with scientists and make them available to parents and community groups. Other schools planned school assemblies open to the public to highlight NES support through AESP specialists, and a variety of related activities requiring parental participation. Communicating with parents via newsletters and web pages were other means for implementing connections to families and the general public.

What is the quality of professional development supports?

In general, the NES program has the potential to be characterized as a reform type of activity because of its emphasis on teacher study groups, teacher collaboration, and network development. The focus on teacher-teams from the same school (primarily) and grade level should increase the likelihood of productive participation. Also, the sustained professional development support over a three-year period should allow for productive experiences. In this section we summarize the perspectives of both program participants and staff from field centers about the nature and quality of professional development supports including summer workshops, on-site supports, institutes, and special events.

Summer 2003 Workshops

The initial summer workshop at the regional NASA field center is a critical event in the program design. The way the workshop is designed and delivered provide an indication of: (a) the existing organizational capacity to deliver high quality professional development, and (b) emphasis in content. Participants were consistent in confirming their overall satisfaction with the program. About 40 percent of participants indicated that the workshop was worth their time. Nonetheless, participants reported many issues related to the quality of summer workshops, which may have implications for improvements in the design and implementation of support structures in the program.

Based on a framework of effective professional development activities identified by Garet and associates (2001), we analyzed available data addressing quality features included in the framework. A brief outline of the quality features is presented in the analysis section of this brief (p. 10-11). The perspectives associated with each feature stemmed from the analyses of all available data.

Type of Organized Activity. Given the nature of a 3-year commitment to support school teams, and based on the type of supports provided in Year 1 of the program, the NES professional development program seems to fit the reform-type of activities. Reform-type of activities emphasizes teacher involvement in study groups, teacher collaboration or networks, committees, mentoring, internships, and use of resource centers. In addition, the expectations and goals center on specific needs for improvement and are usually thought of as sustained endeavors that have school-wide implications.

First, participation is for school teams who enter the program with common and specific goals, and with the idea of enhancing their collective competence. Second, summer workshops are designed for school teams and provide opportunities to generate team rapport and shared understandings. Third, on-site visits by field center staff during the school year ensure continued support and follow up of progress toward goals. Fourth, individual interests are met by facilitating participation in regional and/or national conferences of personal or team relevance (e.g., NCTM or NSTA meetings). Fifth, special events such as History of Winter and KC-135 Aircraft provide additional opportunities for in depth study of relevant topics. Finally, electronic networking via the web and e-mail allow for fluid communication between program staff and school teams. Under this design, the expectation was that teacher learning would build upon core ideas shared during summer workshops, and should occur anytime during the school year as a result of institutes; site visits by field center staff, and/or participation in special events.

Content Focus. A review of summer workshops' agendas indicated the content focus of workshops was somewhat high on content knowledge (e.g., science, technology, and engineering) and action planning. Overall, participants spent a combined 85 percent of the time in related activities. However, about a third (35%) of the school teams suggested there was actually not much quality time spent on action planning. As one participant put it, there was "too much talking. Lots of simultaneous things with deadlines, but there was little time to work on the strategic plans."

Curriculum integration and instructional strategies received secondary attention, while career education and family/parental involvement strategies were virtually absent. In general, participants spent most of the time (72% of the time) being exposed to a wide array of non-curricular NASA resources and field center capabilities and facilities. To a lesser extent, participants spent time using NASA curriculum products and/or on presentations/demonstrations conducted by scientists (Hernandez et al., 2004). In general, the majority of school teams (60%) suggested the summer workshops focused on too much content and proposed an alternative: "to let teachers choose their area of interest to fit individual needs and allow for more time to ask questions and reflect/process information."

Duration of the Activity. The duration of NES professional development activities ratify the qualification of reform-type program. The average duration of reform-type activities is 35 hours, and 23 hour for traditional activities (Garet et al., 2001). By

comparison, the average duration of NES summer workshops was 43 hours, not including additional contact hours due to participation in Institutes (day-long), on-site visits (variable duration), and/or special events (week-long). Garet and Associates (2001) further indicate that the span of traditional activities is 2-4 days, and nine months or more for reform-type activities. The NES program also exceeds this indicator based on a 3-year commitment and program of activities offered in Year 1. The expectation is that extended professional development activities should create the conditions for productive participation in the program.

The majority of participants (60% of school teams) appreciated the workshops but felt they were too hectic or overwhelming (50%). Although participants appreciated the exposure to the wide array of NASA educational resources, there was a pattern suggesting that scheduling needs improvement. Below are some related comments expressing this perspective:

> *We rushed through the activities and didn't have time to process how they could be processed in our schools.*
>
> *Exhausting. It was a sensory overload trying to compact so much information. Teams need to be able to meet earlier than 10 PM.*
>
> *All team members agree, but understand it was the first workshop and there would be bugs. However, we got up early and stayed really late (2 AM working on projects and the action plan). It was a packed agenda. If some of the things were better orchestrated, we'd have had less hectic schedule.*

Type of Learning Activity. Research suggests that reflective and experiential learning as an intrinsic component of professional development has a positive impact on teacher growth (Schifter, 1996). For example, when teachers experience curriculum development activities, and engage in reflective dialogue with colleagues, they are more likely to report professional growth (Garet et al., 2001). To this end, a review of summer 2003 workshops' agendas showed that participants spent more than half of the time (58%) in professional development activities requiring active learning counting time spent on strategic plans.

Related feedback indicated the actual quality of these activities was limited. In some instances (35%), what would have been time for reflection on action planning turned into a highly directed session with little discussion. In other cases (25%), the workshop was not able to accurately model classroom activities due to problems with technology and/or limited time for appropriate preparation. For example:

> *I don't think we truly did any inquiry-based stuff in the workshop. It takes time and we didn't have that kind of time. It was introduced and we played with it a bit.*
>
> *Participants were thrown cold into the e-mission activity and were confused about the purpose and what they needed to do. On top of that, there were some technical glitches and the team wondered whether they would be able to run the activity in the school.*

Some participants felt "more concrete examples and lessons would have been better." Although there were instances where participants were provided with opportunities to reflect on learning activities, there was always the pressure of moving on to the next lesson and or activity in the schedule. As a result, school teams (30%) felt they needed more time to think about the implications for use in their schools:

> *What do we need to consider? How can we use the resources? What are our goals? Mind-mapping some of those things to help the team become more focused. It would have helped the team decide how to spend the $10K grant. For example, we only had one evening to truly work on the action plan. It was late (8 PM) when they got started and they had one person from the field center who could help. Got lots of examples of inquiry-based learning, but did not have time to reflect on it.*

Type of Participation. When teachers are provided with opportunities to work in teams, they are more likely to report more productive experiences (Newmann & Associates, 1996; Talbert & McLaughlin, 1993). This appears to be particularly the case when teacher-teams are from the same school, department, or grade level. This is another feature clearly met by the NES program. School teams participated in summer workshops, and also had the opportunity to participate as teams in Institutes and/or special events. The common focus on middle grades, and on science, mathematics, geography, and technology curricula is at the core of the NES program. The expectation is for school teams to work together over a three-year period and serve as the hub for school-wide dissemination.

Given the interdisciplinary nature of team membership and the approaches for selection (e.g., convenient selection), for the majority of school teams the summer workshop was an opportunity to build internal rapport. To this end, there were opportunities to socialize and have plenty of informal interactions with team members and with other teams in the program. Working on the strategic plan during the summer workshop was a welcomed team activity. Meeting field center staff was also appreciated because of the opportunity to make "friends with someone in the program who provided a lot of insight."

However, given the nature of the workshop schedules, it appeared that school teams had difficulty finding quality time to develop strong professional rapport. The analysis of content, duration, and type of learning activities suggest that school teams focused on completing tasks as scheduled and this did not always facilitate team rapport and/or networking with other teams and field center staff. In this context, teamwork sometimes had to be conducted late at night and it was not conducive for building strong internal and external connections. A team provided the following explanation:

> *We all talked about it when we were working until 2 a.m. Field center staff wanted us to build team relationship with other teams, but we couldn't work with them. Only had time for our team to work together to accomplish projects and action plans.*
>
> *Field center staff wanted us to get to know people better but housing arrangements were not conducive. Also, we did our planning*

at night since our field center wanted 90% of our action plan done by the time we left. They had good intentions, but it was not a good idea. We didn't have enough time to work on our action plans during the day when everyone was in a big room. It was so loud, hearing everyone else. A lot more came at night and we'd had time to reflect.

The need for more time devoted for genuine team reflection emerged consistently from participants' feedback in focus groups. The arrangements for teamwork were also a consideration and another source of suggestions for improvement. Participants suggested: "We could have done better if we had had breakout rooms. Breakout rooms would have been better than break out tables."

Coherence With Other Learning Activities. The review of top academic priorities indicated a high level of coherence between participants' goals and NES objectives. In a broader level, school teams anticipated building upon existing efforts to maximize their participation in the NES program. Overall, 45 percent of school teams had something to say in relation to the relevancy of summer workshop experiences. In general, participating school teams appreciated an insider's exposure to NASA educational resources and identifying what teachers "could take back into the classroom to share with the students." Participants also appreciated the insights on potential applications for integrating NASA resources and current practices in their schools.

For school teams, helping them see the alignment of NASA resources with school practices in the context of state standards frameworks was particularly important. This was even more relevant in relation to pedagogical strategies for improving teaching and learning of mathematics and science. For some teams the summer workshops were an eye opener in this regard.

In some cases where the participants represented elementary grades the relevancy of content was somewhat limited since it was more appropriate for middle grades. In other instances, some participants felt they needed "more interdisciplinary full units with complete lesson plans for integrating science and math into the curriculum, more time going though those units." Since participation in the program is based on the premise of team approach and school-wide implications, teachers realized they should approach content—especially at the middle school level—in interdisciplinary ways. Further, emphasizing local relevancy was also mentioned as an opportunity for improving the potential value of workshop content. For one participant, "content more focused on geographical area—for example, Great Lakes pollution—would add relevancy to students."

All in all, participants recognized that it was a challenge to balance exposure and relevancy in one week. The bottom line for them was to have time for true reflection in establishing connections for practice back in their schools, and finding resources that will meet their needs. The following insight summarizes this perspective:

Given that you only have one week, it is challenging for NASA to fit it in one week. I can only speak from my state's perspective. Teachers are looking for hands-on activities that work within a context that fits into standards. We know they scream for resources. Part of what we

feel our role is to find products and activities that we can share with other teachers. Certain things they have to do.

On-Site Professional Development Supports

An important component of the NES professional development design is the commitment to support school teams during a 3-year period. This commitment requires AESP specialists affiliated with each field center to design and deliver a program of professional development supports for corresponding clusters of schools during the school year. On-site supports ranged from programs based on a pre-determined number of site-visit days to open approaches consisting of site visits as needed or built around the travel schedules of AESP specialists who conduct outreach activities for field centers.

In general, participating school teams reported an appreciation for the professional treatment they receive from the program and field center staff. School teams have the perception that field center staff and headquarters are "very interested in trying to make this work for us. Every one tried to make this successful." In this context, the majority of school teams (60%) identify communication as a critical issue in their interactions with field center and program staff. In early fall, the teams reported this as a problem due to the overflow of e-mail communications originating from headquarters and from field center staff. This was particularly problematic for team leaders or the appointed contact person since all communications converged to this person. This issue was later resolved as headquarters instituted a practice of sending all e-mail messages on Monday. Once the issue was resolved, school teams found that electronic communication afforded immediate contact with the corresponding field center staff. Establishing clear points of contact at both ends (schools and field centers) appears to be of outmost importance to assure effective communication. Otherwise, breakdowns in the system may occur:

Most of our information went to this one person and not to all three at our corresponding field center. This person didn't reply to things. When the other two found out, they were upset. Why didn't we contact them? But we didn't know if we could contact them.

The nice thing with field center staff is I can directly email to the field center education officer or appropriate field center staff. Prior to the new regime I just used to go straight to headquarters.

Overall, participants feel field center staff have been very friendly and responsive to their needs for educational materials and access to resources. Sometimes materials have been provided in spite of short notices. The only area that takes more doing is accessing scientists for a variety of activities (e.g., guest speakers, demonstrations). School teams took the offer to access scientists literally only to find out that this type of access was not as expeditious as material resources. A school team suggested it was important to convey related access more accurately to participants for planning purposes.

Another area of support addressed by participating school teams was assistance in producing strategic plans. School teams believed field center staff had good intentions and were eager to help (55% of school teams), but in many ways they felt frustrated with the uncertain process. It was their perspective that the expected format for producing strategic plans kept changing and had to revise them many

times before final submission. Since it was apparent that field center staff was also uncertain about specific expectations, related feedback was somewhat limited. School teams further voiced their frustration for the lack of follow up feedback after submission. The following accounts illustrate this situation:

> *It reminded me of the military when I was asked to write lesson plans where lesson plans have never been before. A work in progress, they weren't sure of what they wanted. Like first planning a unit in your classroom, then you find out the bugs. The changes were frustrating. We redid our action plan at least 5 times. Some changes were ours; some were because Headquarters changed the format.*

> *We gave the field center staff a rough draft filled in an outline, which they basically later dumped. A month later they said we have to have the action plan. We kept trying to get feedback. What does this want? Never got the feedback. When we submitted early, we submitted for feedback and we did get back input, and then we took it on out own. They rearranged the whole thing. Final draft we sent it to them Oct 5, 6, 7, and they kicked it back with corrections. Just corrections but no feedback. But by then we were communicating.*

After summer workshop, the expectation was that field center staff would visit affiliated schools to follow up with assistance identified in implementation plans. Based on focus groups, on-site supports varied widely depending on the organizational approach followed by field centers. Some centers pledged a certain number of site visits per school in their region of service. Other centers built on-site visits around the schedules of AESP specialists doing outreach in schools. In other cases, on-site visits appeared to be influenced by the size of regional service as some centers serve several states in a relatively large area, compared to other centers serving single states. As a result, school teams' reports on site visits varied widely, from very limited contact to rave reviews of follow up supports. Below are two contrasting accounts:

> *We've had just one contact with the AESP specialist. We expected several teleconferences, but only one call happened. Feels like there was little support after the workshop.*

> *Great! The AESP specialists came to family science night, brought moon rocks for a program, and came for e-missions program with staff and community kick-offs.*

NES Institutes

To ensure a breadth of professional development opportunities for NES participants, the program provided a $1,000 stipend for each of five slots in a school team. Use of these funds was actually open to anyone in a given school to broaden participation in professional development of interest by allowing them to attend conferences of their choice. This way, participants would be able to complement and enhance their professional development, as well as share the benefits of participation with others in their school. To disseminate program information and create awareness in the field targeting specific audiences (e.g., school administrators), the program provided informational receptions and content updates at other forums during the year.

Overall, a total of 179 NES participants (72% of the 2003 cohort) took advantage of these opportunities (see Table 4).

Table 4. Institutes and other NES outreach activities offered in Year 1

Organization	Meeting Location	Date	NES Institute	Count
National Council of Teachers of Mathematics (NCTM)	Salt Lake City, UT (Regional)	Oct 2-4	NO*	3
	Charleston, SC (Regional)	Nov 6-8	1	5
	Philadelphia, PA (National)	April 21-24	R, CU	18
National Science Teachers Association (NSTA)	Minneapolis, MN (Regional)	Oct 30-Nov 1	1	3
	Kansas, MO (Regional)	Nov 13-15	1	5
	Reno, NV (Regional)	Dec 4-6	1	30
	Atlanta, GA (National)	April 1-4	2, R, CU	76
National Middle School Association	Atlanta, GA	Nov 6-8	NO	7
National Alliance of Black School Educators	Reno, NV	Nov 18-23	NO	1
International Space Station Educators Conference	Houston, TX	Feb 6-7	NO	2
American Association of School Administrators	San Francisco, CA	Feb 19-22	R	1
National Association of Secondary School Principals	Orlando, FL	Feb 27-Mar 1	R	1
International Technology Education Association (ITEA)	Albuquerque, NM	March 18-20	CU	24
National Congress on Aviation and Space Education (NCASE)	Atlanta, GA	March 24-27	CU	1
National School Board Association (NSBA)	Orlando, FL	March 27-30	R	0
National Association of Elementary School Principals (NAESP)	San Francisco, CA	April 16-20	R	2
			Total Number of NES Participants:	179

*Notation: NO = Not Offered; R = Reception Only; CU = Content Update Only

Since it was anticipated that most of the NES participants would attend regional and/or national meetings of the National Science Teachers Association or the National Council of Teachers of Mathematics, the NES program offered Institutes at the majority of those meetings. The content of the Institutes varied to meet the participants' interests in the context of a particular conference. A total of six Institutes were offered in 2003-2004 and designed around the following topics: Exploring inquiry through rockets, mars core content update (2 sessions), Space Science Telescope Institute (Hubble update), centennial of flight, and NASA Aerospace Technology Enterprise.

Based on overall attendance to conferences (n = 179), participation was more prominent at NSTA meetings (64%), followed by attendance to the NCTM meetings (15%), and ITEA conference (13%). The rest (8%) attended either a conference for administrators (e.g., NAESP) or a conference targeting other interests (e.g., NCASE).

NES Special Events
In Year 1 of the program, two special events were made available to NES participants: History of Winter and KC-135 Reduced Gravity Aircraft. These one-week long events were designed to provide in-depth study of a topic of interest and connections to classroom applications. A total of 28 educators participated in the events.

History of Winter (HOW). The History of Winter (HOW) NES special event was a week-long workshop held at Lake Placid, New York during the winter of 2004. Twenty-two teachers, representing 14 schools, participated and were supported on-site by their AESP specialists, three Goddard Space Flight Center Special Project Initiatives (SPI) specialists, an NSTA instructional technologist, and five experts in glacier ice and snow, winter ecology, low-temperature microscopy, and the iBUTTON thermochron tool. Participants were expected to develop understandings of situated scientific inquiry, curriculum integration, content knowledge, and technology integration. According to an organizer, the goal was to get teachers "away from the classroom and focus on protocols of snow and ice study and what is required to do science field research. Give them that experience to behave as scientists."

HOW activities were almost evenly split between hands-on fieldwork and activities involving lectures and/or demonstrations. Participants spent most of the time (94%) in activities where scientists were used as resources. In general, the majority of the activities (63% of the time) focused on content knowledge, while about a third of the time participants focused on curriculum integration. Further, almost half of the time the participants engaged in snow and ice field studies using authentic tools, but it appeared the quality of the instructional design limited the development of deep understandings. One participant provided an account of these limitations, while recognizing later improvements:

> *When we performed the experiments we had no idea what we were doing because it was not explained. Later in the week, after things were explained, the experiments made more sense. But it was frustrating to do the experiments while not knowing what we were doing.*

In the evaluation of the event, participants were asked to indicate their level of agreement with 41 evaluative statements (from 1 = strongly disagree to 5 = strongly agree). The statements gathered feedback on the overall value of the event, specific benefits, teaching and learning practices, potential impact, and overall satisfaction. Table 5 reports statements that received a rating recognized as exemplary (4.7 or higher average rating). In general, participants appeared satisfied with the event (overall average rating = 4.3). However, only broad statements about NASA's role and potential impact received exemplary ratings. In a key area involving eight items related to teaching, learning, and use of resources, participants tended to be satisfied but appeared less enthusiastic (average rating = 3.9).

Table 5. Average rating of evaluative statements on the event

NASA's offering the program to educators is a good investment of taxpayer funds	5.0
Participation in the program will help me with my career path	5.0
Offering the program to educators is a good use of NASA resources	4.8
[The expected program impact will be on] inspiring students	4.8

All in all, taking the event as a whole, participants appreciated the unusual opportunity to experience activities they would not normally do in a workshop, and about the unexpected implications for teaching and learning. Below are two examples.

> *Getting to do things that I normally would not get to do like sleeping in a snow cave, climbing an ice wall, taking cores from a frozen lake. I also enjoyed getting to meet other NES teachers and learn about what they are doing in their schools.*
>
> *With as much snow as we get in our state I know that this is something that I will be able to use. I never really thought of snow as a learning tool before this.*

KC-135 Reduced Gravity Aircraft. NES participants also had the opportunity to participate in the Johnson Space Center "KC-135 Reduced Gravity Student Flight Program." The typical duration of a KC-135 mission is 2 to 3 hours and consists of 30 to 40 parabolas or arcs. The aircraft flies these parabolas in succession or with short breaks to reconfigure test equipment. During each parabola, there will be 20 to 25 seconds of weightlessness and the opportunity for conducting experiments.

Three school teams participated in this event. Each team consisted of two teachers, a NASA mentor and an AESP specialist. Before the event, teachers had students design a research question that could be tested in microgravity. Student questions were accepted based on the nature of the question, whether the experiment met KC-135 standards, and proposed analytical strategies. At the Center, the teachers experienced what the astronauts do in pre-flight training including a program orientation, physiological training in a hypobaric chamber, and a readiness test to ensure that all experiments would be ready for flight. Teachers were split into two groups and alternated flight times over a 2-day period. At the end of the event, teachers were asked to indicate their level of agreement or rate 17 evaluative statements (from 1 = strongly disagree to 5 = strongly agree), whereby a rating of 4.7 or higher indicates an exemplary level. The statements gathered feedback on the overall value of the event, quality of organization, and overall satisfaction. In general, participants were highly satisfied with the event (overall average rating = 4.7). Table 6 reports statements that received an exemplary rating. In general, participants were highly satisfied with the program leaders and the overall program (average rating = 5.0). Teacher comments support evaluation ratings (NASA News, 2004):

Table 6. Average rating of evaluative statements on the event

Participation in the program was a good investment of my time	5.0
The program was a valuable experience	5.0
The program was well organized	5.0
I expect to apply what I learned in the program	5.0
I would recommend the program to someone else	5.0
I acquired the skills and/or knowledge offered to participants	4.8
A NASA mission, project, or focus area was used as a theme throughout the program	4.8
I have a better understanding of NASA's support for education	4.8
The program was inspiring	4.8

This was my dream, and it could very well be a student's dream in my classroom or school. I wanted to make sure I made my time in the KC-135 count. I could not let my students down.

I think that one of the great benefits was the unique experience to share with students and a product (that they can see) to help them learn about scientific inquiry.

This program encourages youth and teachers to explore the world of science deeper. It takes their ideas and turns them into reality and emphasizes the "can do" attitude.

How did overall program strategies facilitate participation?

In addition to direct professional development supports provided by field center staff, the NES program (i.e., NASA headquarters executive team) also established structures to ensure successful participation. Overall guidance is, perhaps, the most important support provided to both field center staff and school teams. Establishing a communication structure to share and facilitate access to information is also a key role played by the NES executive team. Further, contribution to administrative and programmatic supports to school teams complemented the direct supports provided by field center staff. In this section, we summarized the perspectives of participants and staff from field centers on overall program supports.

Participants' Perspectives

In general, 35 percent of the school teams addressed overall program supports. School teams talked about expected wrinkles in the program during the first year, the application process, communication, and supports on strategic planning. First, school teams voiced their general satisfaction with program supports and expressed their understanding of the program as a work in progress during the first year. In this context, there was an insistence that their comments were only meant to help the program improve some areas of support.

For example, during the application process school teams felt that they did not have enough information on the program. They also indicated receiving the information late and having little time to prepare an application. Schools were contacted by field center staff and invited to apply, and schools wrote applications under sketchy guidelines. A school team suggested more thorough and timely background information to help schools decide on participation and do a better job in preparing an application:

Background information would help at the application process. Had nice brochures, but I think that if they had gotten them out in the schools in October or November, would have given school enough time to decide and plan. Our field center called us in the spring, "Would you be interested in writing a grant proposal?" I wrote it in two days, not knowing what I was getting into.

Further, communication was initially a problem due to the heavy bulk of electronic information and regular mail flowing from program structures to school teams. Once this problem was resolved, electronic messaging remained as the primary means for communication. On a programmatic level, school teams were overwhelmed by the amount of paperwork upon enrollment in the program. Most importantly, they felt

there was no clear feedback about procedures and specific requirements for information.

For schools, timely supports were also critical in supporting their preparation for summer workshops. Thirty five percent of the school teams reported receiving the outlines for strategic plans just before they attended the summer workshop. Developing the strategic plans was an issue that created some anxiety and frustration due to glitches in the process, as some teams could not access the forms online. In other cases, school teams felt they could have completed their strategic plans more efficiently had they had better feedback.

As school teams continued to experience the program, they realized that its design was an evolving undertaking. In the process, it created some degree of uncertainty that trickled down to field centers and, in turn, to school teams. At the same time, school teams recognized that it is all part of being in the first cohort, first year of the program. At the same time, school teams appreciated the fact that headquarters was addressing issues and communication improved as the program progressed in the first year. The following comment summarizes this perspective:

> *It seemed really obvious that this is the first year of the program for NASA as well as for us because none of us is sure which way we are going to go. It is frustrating at times, but I understand how things can be with a pilot and I look at it as an opportunity. As we muddle our way through the budget process, and this whole video processing thing, the rules are changing under our feet. However, NASA headquarters keeps us well informed as they do change.*

Perspectives from Field Center Staff

Insights from field centers staff echoed the themes expressed by school teams. Staff from at least half of field centers talked about design and programmatic issues, and recognized that related issues were an expected result of early implementation of a complex program. Initially, staff felt the program started too fast and, in the process; there was limited specific guidance about program implementation from headquarters. To this end, field center staff suggested the need for better communication, organization, and explicit guidelines and criteria for program implementation. One specialist suggested that, to implement the program, they initially needed a blueprint just as bricklayers need it to construct a building. At the same, there was recognition of the urgency to implement the program and the nature of the evolving process in the early stages of the program.

On the issue of providing assistance and supports to school teams on completing forms for different purposes (e.g., needs assessment, strategic planning), field centers confirm school teams' account. In some instances problems stemmed from ambiguous instructions, and in other cases they were related to timely provision of forms. A field center, for example, noticed that needs assessment forms were not fully understood by school teams and had been incorrectly completed due to unclear instructions. As for strategic plans, field centers reported that some schools didn't receive the guidelines prior to attending the summer workshops and required teams to make corrections to plans on the fly during the workshop. For some teams and field center staff, this issue was a source of frustration.

Another issue was the way expectations were communicated to teams. Field centers felt the extent of overall supports was not clearly delimited and it created some confusion for school teams. Initially, headquarters suggested open access to both educational and personnel resources (e.g., access to NASA dignitaries to support kick-off events at schools; astronauts to support an event a year). Regarding curriculum materials, some problems stemmed from timely supply for distribution purposes but were easily solved. The problem that appeared to create some tension between school teams and field center staff was related to accessing NASA personnel since scientists were not readily available as promised.

To overcome problems with communication, facilitate feedback and avoid waiting periods, field centers suggested holding a NES program managers meeting to keep everyone informed of new developments and get answers to questions. This meeting was later instituted on a monthly basis and included a recap of events, issues, actions taken, and upcoming events. This has been an opportunity to get updates from key contributors (e.g., WebWatchers: an NSTA program that trains teachers so they can research and select Web sites that can be integrated into science curricula), and individual field centers.

As field centers pondered the additional roles and needs for providing effective support to school teams, they voiced the concern that the AESP program may loose its original focus to serve all states and schools within states due to the incremental responsibilities posed by the NES program. They also expressed a concern about their capacity to deliver assistance as the NES program continues to grow in the next few years. To this end, the issue of cost-sharing was raised since funding for workshops, additional travel, and videoconferencing has to be covered by field centers.

The issues mentioned above seemed to have been satisfactorily addressed by headquarters at the end of Year 1. A key decision was the addition of a coordinator at each field center to support program activities and facilitate the work with affiliated school teams.

What is the impact of participation at the end of Year 1?

At the end of Year 1 of the program it was only possible to evaluate the impact of program participation in two areas. One area of interest addressed broad benefits for schools and students as perceived by participants. The other area involved changes in teachers' beliefs about effective practices in teaching, learning, and use of technology.

Perceived Benefits for School/Students

The evaluation of summer workshops showed that participants had very positive views on the overall NES program (Hernandez, et al., 2004). The program, the content focus, and staffing were all rated high, and open commentary suggested a high level of appreciation for the NES program and the associate with NASA. Participants reported developing a better understanding of NASA's role in education and the wide array of curriculum products and resources potentially available to them; and enhancing their awareness and interest in science, engineering, technology, and mathematics. Ultimately, participants anticipated an impact on their students through eventual improvements in teaching, learning, and connections to the community.

Focus group data further supported the positive views on program participation and underscored the excitement of teachers about using NASA educational resources as a means to raise student interest in science, mathematics, and technology. By the time of the fall interview, school teams provided tidbits of emerging evidence suggesting promising implementation strategies and, in turn, potential impact on teaching and learning with school-wide implications. Schools with a sense of renewal saw participation in the NES program as an opportunity for accessing valuable thematic NASA resources and related professional development supports. School teams that appeared more proactive in building department-wide and/or school-wide NES communities were more likely to report positive experiences and results in Year 1 of the program.

In one case, a school team used NASA resources to organize a thematic event they called "NASA Day." During that day every teacher in the school was involved:

> *Math teachers did galactic mobiles and talked about scientific notation. English teachers did acronyms. History did timeline. Science did several, and top ten reasons to be an astronaut. Fifth grade did phases of the moon. They built a rocket by inquiry, math to estimate the distance and how to improve the rocket. Made rovers. Fourth grade made a moon buggy and had to decide everything astronauts would need in outer space. Had just completed pioneers of the Wild West and made a box of what they would need to take out west. And then for NASA day, a box for what they would need in space. And they found the boxes were very similar. Art made seventh grade rockets and eighth planets. It was our kickoff.*

At another participating school with a total of 68 teachers, the entire math and science departments were contributing to NES efforts. The school team had purposefully developed a strategic plan with the whole school in mind and building upon the school improvement plan. The school teams explained the benefits of this approach:

> *So 100% of the teachers were on board. As far as using NASA materials, for NASA assemblies, 100% of the school was included. The art teacher is painting Mars murals in classrooms. The direct curriculum resources trickle down to the other teachers because of the structure of the school learning community.*

In other instances, participation in the NES program is seen as an opportunity to foster interdisciplinary teacher collaboration using the school team as the initial nucleus. Concurrent benefits were reported as teams conduct program kick-offs open to parents and the general public. These and other NES activities are extended to the community and used as a leverage to improve the image of the school, raise interest and support in science and mathematics, and create opportunities to leverage funding support from community groups and/or businesses.

Impact on Participants

The Teaching, Learning, and Computing Survey (Becker, 2000) is a questionnaire designed around five underlying constructs each aligned with constructivist principles for teaching and learning: technical skills (TS), constructivist teaching strategies

(CTS), attitudes toward technology (ATT), constructivist teaching philosophy (CTP), and constructivist uses of technology (CUT). The results are presented in Table 7.

Table 7. Changes in teachers' perspectives on teaching practices and use of technology in the classroom

Construct	Date	Mean	Std. Dev.	*t*	*df*	*p*
TS	Fall 03	3.309	0.670	3.197	93	0.002
	Spr 04	3.451	0.611			
CTS	Fall 03	3.068	0.642	2.256	88	0.027
	Spr 04	3.171	0.587			
ATT	Fall 03	3.840	0.449	2.289	93	0.024
	Spr 04	3.938	1.432			
CTP	Fall 03	3.422	0.371	1.498	95	0.137
	Spr 04	3.478	0.368			
CUT	Fall 03	2.413	0.812	9.614	87	<0.001
	Spr 04	2.990	0.777			

Constructivist ideas for teaching and learning have emerged from research about how people learn. Supporting principles are based on the notion that learning is about knowledge construction rather than reproduction. Under these principles, students learn by building upon what they already know. Constructivism is also based on the notion that learning is affected by the context in which an idea is taught as well as by students' beliefs and attitudes (Caine & Caine, 1991). Thus, it is expected that by immersing teachers and students in problem- and/or inquiry-based teaching and learning and related resources under themes relevant to NASA's work, improvements in learning will occur.

The scale used to gauge constructivist perspectives and beliefs ranged from 1 (very traditional) to 5 (very constructivist). To test changes in perspectives related to evaluation constructs, five paired-sample t-tests on the means of each evaluation construct were conducted using pre- (Fall 2003) and post-data (Spring 2004) collected in Year 1. The results presented in Table 7 show that constructivist uses of technology ($p < .001$), technical skills ($p = .002$), attitude toward technology ($p = .024$), and constructivist teaching strategies ($p = .027$) had statistically significant increases from Fall 2003 to Spring 2004. These results indicate interest and awareness in using technology to support learning increased by about half a point in the scale of constructivist uses of technology. The relatively minor changes in the other three constructs suggest that participants may be feeling more positive about technology in general, and—in turn—a little more comfortable in their ability to use technology. The fact that no significant change was observed in constructivist teaching philosophy ($p = .137$) may be due to the more complex nature of this construct. It is also possible that changes in understanding and seeing the value of practical applications need to happen first before a change in philosophy occurs.

Conclusions and Implications

The evaluation work conducted in Year 1 of the program focused on six guiding questions, each trying to document a key component of the NES program as an educational intervention. Three questions emphasized areas related to the participation of school teams, two questions looked into the nature and quality of professional development supports, and the last question gauged the impact on

teachers and schools at end of Year 1. What follows is a summary of major findings and lessons learned that emerged from this initial evaluation work.

Conclusions: Major Findings from Year 1

The NES program is serving underserved schools, teachers, and students targeted in the program design, and it is providing a comprehensive portfolio of both curriculum and professional development supports. School teams, in turn, are trying different ways to organize themselves and approaching strategic planning according to their needs to maximize participation. Given the complexity and magnitude of this endeavor, it appears that both school teams and program staff are learning that long-term improvements and large-scale organized supports are not easy to implement. The coherence of program implementation, in general, proved challenging and needs additional work. At end of Year 1, it is apparent that design decisions can be improved in terms of school team organization and participation, and in terms of the total design for professional development supports. All things considered, participants provided positive feedback on program participation and appreciated the connection to NASA's educational efforts. Concurrently, the NES program—in the context of design changes and improvements—appears to be well positioned in helping school teams meet their goals.

Serving Underserved School Communities

One of the objectives guiding the NES program is to provide "academic assistance for and technology use by educators in schools with high populations of underserved students." Given the contextual background of the 2003 cohort of participating school teams, it is evident the NES program is meeting this particular objective.

In the 2003-2004 school year, 50 school teams involving a total of 61 schools (primarily middle schools) participated in the program. Collectively, participating school teams represented 30 states, and more than half (58%) of them are located in high-poverty areas in rural, urban, and suburban locations all across the nation. Not surprisingly, the majority of participating schools have limited technical capacity to use educational technology for teaching, learning, and outreach/communication purposes. Also, the program is reaching out to more than 35,000 students through participating schools. The majority of these students have been traditionally underserved. Concurrently, program participants (250 educators) have the appropriate background in terms of preparation, area of instruction, motivation, and can benefit greatly from participation in the program. In general, we can say the NES program is clearly meeting the objective of serving school communities operating in challenging circumstances.

Facilitating Vision and Process for Participation

Another guiding objective of the NES program is to facilitate "active participation and professional growth of educators in science, mathematics, and technology." This objective, it involves strategies and supports designed and implemented by both participating teams and NES structures. Differences in the quality of organizational strategies were observed, stemming perhaps from initial limitations in understanding of potential benefits and expectations for participation in the program. Expectations, for the most part, focused on accessing and using NASA's educational materials and resources.

Working in interdisciplinary teams guided by school-wide goals proved to be a challenging experience in most cases. Teacher turnover, team dynamics,

administrative support, and community supports are crucial factors that facilitate or hinder effective participation in the program. School teams reported a wide range of experiences in Year 1. School teams with clear and shared expectations, high administrative support, collaborative teamwork (e.g., shared responsibilities), proactive strategies, and approaches seeking community support, appear to be better positioned to maximize program participation and meet their goals. Similarly, the quality of strategic planning varied widely. In general, top academic priorities reported by school teams are aligned with NES academic objectives, while implementation plans signaled complementary strategies to enhance family involvement. However, planned activities related to career interest supported by science, mathematics, and technology appeared to be—at best—an afterthought in both strategic and implementation plans.

Overall, program orientation before and during initial summer workshops, support and feedback conceptualizing strategic and implementation plans, and collaborative team planning may represent potential improvements in facilitating the vision and process for participation.

Supporting School Teams

All things considered, school teams expressed their satisfaction with overall supports they have received in the program. They appreciate the association with NASA's educational efforts, access to related resources, and the variety of professional development supports. School teams insisted any issues or concerns expressed in focus groups were not indicative of dissatisfaction, but a way of helping the program improve in certain areas.

Given the short period for preparation; field centers did the best they could in designing and implementing summer workshops. They basically compacted traditional two-week workshops into one-week events with the goal of providing maximum exposure to the wide array of educational materials and resources available through NASA. Although school teams appreciated this exposure, it was unclear how the workshops were customized to meet the needs of school teams. As a result, participants' feedback suggested the need for more detailed orientation prior to the workshops, reducing the scope and enhancing the depth of activities, and providing more time for team reflection during the week.

Overall, on-site support from field centers appeared to be organized around site visits in the form of discrete events that needed to be squeezed in the busy schedule of center staff. Depending upon the approach followed by field centers and on their established capacity for outreach (e.g., number of AESP specialists, established travel schedules, size of service area), the support provided to schools appeared to vary greatly. Typical assistance would consist of demonstrations and brokering the participation of NASA scientists in special events.

Additional professional development supports through institutes and special events were also highly appreciated by program participants. The opportunity to attend conferences of interest either individually or as a team was seized by 72 percent of all NES participants. Further, the special events History of Winter and KC-135 Aircraft signaled the program commitment to provide professional development targeting specific themes in-depth and with high potential for classroom applications. Initial experiences showed that participants have enthusiastically embraced these

opportunities, although it appeared improvements are needed to enhance the instructional design of such events.

Overall, school teams recognized the important role of headquarters in guiding the program and the willingness to address early issues (e.g., communication). Once expectations and rules for participation and coordination were clarified, school teams appeared to be more focused and motivated. Likewise, listening to field centers and establishing administrative structures for coordination, communication, and feedback (e.g., monthly teleconferences), helped developed shared understandings for implementation. The addition of a coordinator at each field center signals the program commitment to support the work of field centers.

This is perhaps the area where the program faces its greatest challenge: to move from a culture of outreach and dissemination to one of focused professional development for teams of teachers interested in fundamental changes in teaching and learning.

Impact on Schools and Teachers

The work conducted in Year 1 indicates the program is well positioned to have an impact on schools and teachers in traditionally underserved areas. For schools, it is obvious that participation in the program has been a great opportunity to leverage support in the community; raise parental and community interest in student learning in math, science, and technology; and for engaging teachers in interdisciplinary collaborative activities leading to school-wide improvement in teaching and learning. Kick-off events, activities open to the public, news coverage; all contribute to enhancing the presence of schools in their communities and rally support around their improvement efforts.

In addition to increased and targeted opportunities for professional development, teachers are informed of and given access to a wide array of NASA educational materials and resources. Although actual use of educational resources appears to vary greatly, there is evidence of teachers implementing related activities in creative and coherent ways. Further, scores in the Teaching, Learning, and Computing survey suggest that participants are changing their perspectives (in positive ways) regarding teaching practices, attitudes about technology, and comfort level with use of technology in the classroom. Most importantly, across focus groups and other sources of data, it became clear that participants are proudly embracing participation in the program and are highly motivated in being part of such an important educational undertaking.

Seeking Coherence: Emerging Lessons from Year 1

The logic model for the evaluation of NES program supports in Year 1, allowed us to assess the program in two ways. First, it allowed us to gauge whether participation in the program is characterized by coherent approaches and practices. Second, it also allowed us to explore the extent to which professional development and support structures are meeting the needs of participating school teams. Given the fact that the program can be characterized as reform-type activity, we examined coherence in relation to potential fundamental changes beyond use of resources and teaching practices.

To guide our summative analysis, we drew from literature in school restructuring, scaling of innovative practices, effective professional development, and building

learning communities. A series of lessons emerged in four key areas related to developing shared understandings; establishing connections to curriculum, teaching, and learning; supporting coherent participation; and supporting teaching and learning as a community activity. The intent of these lessons learned is to inform further design and implementation decisions in the program.

Developing Shared Understandings

Common sense dictates that a clear sense of purpose is needed for undertaking any endeavor. This is especially true and challenging when groups with different perspectives and backgrounds participate in a common venture. Educational research provides abundant support for this notion in the context of reform-type activities implemented by interdisciplinary teams of educators including teachers and administrators (Hernandez & Brendefur, 2003; Loucks-Horsley, Stiles, & Hewson, 1996; Newmann and Associates, 1996). In general, the literature indicates that schools with shared understandings of high quality teaching and learning practices, and a clear sense of purpose (i.e., curricular needs) are usually better positioned to reach success in implementing fundamental school improvements. Lesson 1 and 2 emerged in this context.

Lesson 1. *School teams driven by a clear sense of purpose and vision for participation in the program (i.e., those with shared goals and understandings) are more likely to report successful experiences and results*. Across school teams, there were only a few instances whereby the teams showed a clear and shared understanding of direction and purpose. In one case, the team assessed their curricular needs, decided on goals, verified alignment with relevant academic standards, and aligned their efforts with available NES supports. In most cases, however, this level of understandings was not evident. The majority of teams were somewhat unclear, initially, about the nature and scope of their goals and vision for participation. In many ways, the goals across teams were broadly articulated and focused primarily on accessing NASA educational resources as a means to meet NES objectives, but no explanations were usually given about the connection to important changes in curriculum, teaching, and learning.

School teams mentioned being overwhelmed by information upon enrollment and at the summer workshop, and had little quality time for reflection and developing shared understandings of both purpose and vision. Limited feedback provided by field center staff may have played a role too. This issue emerged in the analysis of focus groups and review of strategic/implementation plans. The analysis of program implementation in Year 1 suggests that orientation information prior to participation in summer workshops, and more time for team reflection should help teams developing shared understandings and vision for participation.

Lesson 2. *The emphasis on increasing career interest in science, mathematics, and technology was not clearly articulated across participating school teams. Clear ideas and connections to curriculum, teaching, and learning need to be emphasized to meet the corresponding NES objective.* The explicit pursuit of career connections in the curriculum was virtually absent across school teams. If anything, such connections were mentioned secondarily and usually indicating connections by association. For example, 22 school teams mentioned some broad strategies for career exposure stemming primarily from identification of different roles in solving science problems. In other instances (11 teams), career connections were anticipated to emerge as a byproduct of using guest speakers representing different

backgrounds. Across the board ideas were not fully elaborated in coherent ways and signaled a weak understanding in this area.

Exposure to guest speakers and identification of roles in solving problems are useful to a certain extent, but are unlikely to provide students with strong connections to career interest. From the analysis, it is obvious this is an area school teams appear to be less prepared. As a result, related shared understandings were scattered and teams could not clearly articulate relevant goals and implementation strategies. The teams should seek contributions from career guidance counselors to strengthen related understandings and identify needed professional development. Field center staff, in turn, should make an effort to provide related professional development supports. This is perhaps the area in need of most improvement and/or documentation of related design and implementation decisions.

Establishing Connections to Curriculum, Teaching, and Learning
Visions for fundamental school improvements in science and mathematics usually target what has been qualified as "the core of educational practice," involving teacher beliefs about the nature of knowledge and pedagogical strategies (Elmore, 1996). To make a difference in large-scale efforts, however, participants must address needed changes in curriculum and teaching as a requirement for widespread changes in pedagogical strategies and use of educational resources. Newmann and Associates (1996), reinforced this notion by suggesting that schools that agree on the nature of high-quality curriculum, teaching, and learning; and agree on the type of specific curricular, teaching, and learning resources/activities needed to meet their needs are more likely to succeed in implementing school improvements. Lessons 3, and 4 address related issues.

Lesson 3. *Having important program objectives is not enough. The program should also emphasize a clear vision for meeting objectives to ensure effective participation.* Overall, only a few teams were able to show a direct alignment between curricular needs, goals, and strategies for improvement involving a coherent program of curriculum, teaching, and learning strategies. The majority of school teams focused on access to educational resources, use of technology, and the opportunity to leverage presence in the community through the association with a NASA program. Specific curricular connections are largely absent.

Further, based on data available at end of Year 1, with one or two exceptions, it was still unclear how information on top target standards was used to inform decisions for implementing summer 2003 workshops. This is an important aspect of supporting school teams and helping them focus on what is important. The assistance provided in this regard, for the most part, appeared to be in the programmatic alignment with NES objectives rather than the curriculum/pedagogical alignment needed by teams. Concurrently, field centers reinforced the focus on use of educational materials and resources by putting that at the core of summer workshops. Field centers attributed this situation to the broad nature of the initial program guidelines. As a result, the program initially flooded teams with information on educational materials, resources, and opportunities for professional development. Somehow, the notion of quantity of exposure and/or use rather than coherent use and/or participation seemed to trickle at all levels of the program.

To promote coherence in program participation, it is critical for school teams to clearly identify curricular needs and academic priorities, and use that information to

guide participation and implementation of school activities. To field center staff, this information is essential for guiding the design and implementation of summer workshops and subsequent on-site supports. To the program, in general, it is important to set the tone about what is important: focus on the connections between anticipated curricular changes and offering needed and relevant coherent supports to school teams.

Lesson 4. *The use of NASA curricular resources is central to the definition of the program's intervention. The program should promote targeted use and coherent approaches to implementation to ensure the connection between impact of participation and use of resources.* As in any educational program, impact will be tied to both the extent of structural supports (e.g., technical assistance, stipends) and use of specific curricular resources. School teams talked about the number of NASA curricular resources available to them and were excited about using them. The majority of the schools, however, did not appear to have a planned pattern of use. The common approach was based on opportunity because resources were readily available or due to personal interests, rather than dictated by a clear curricular need. This is not surprising given the flow of information on resources and the perceived pressure to use them. It is at this point when it becomes highly relevant to establish coherence between strategic and implementation plans. It is important that field staff help affiliated team stick to their plans and use resources that clearly meet specific curricular needs. Coherent use should supersede quantity of use.

Recognizing this need, the program is identifying and supporting the development of special events and products with potential for broader appeal and coherent use. Special events featuring targeted professional development on a theme should be useful to school teams. In Year 2, the program anticipates thematic workshops, a series of eMissions specifically developed for the program, and professional development on the use of handheld computers. In addition to this, the program should promote a culture of participation where the specific use of NASA resources should represent a genuine strategic opportunity directly connected to a curricular need in schools.

Supporting Coherent Implementation in Schools

Promoting fundamental changes in curricular and instructional practices is hard work and requires school supports beyond focus on appropriate curricular resources. Recognizing that teaching—as a profession—extends beyond the classroom in the context of a school community, it should be supported accordingly. Strategic approaches and structural supports to help teachers work together are needed to help schools implement coherent improvements in curriculum, teaching, and learning (Kruse, et al., 1994). Some of these conditions and supports take even greater relevance when interdisciplinary teams of teachers engage in collaborative work with school-wide implications (Hernandez & Brendefur, 2003). Related research suggest that schools with a strong professional community provide teachers with conditions to develop shared understandings, engage in reflective dialogue, collaborate in teams, and are empowered to make decisions on curricular and teaching practices. Concurrently, supportive administrative leadership is also required to make sure those conditions are in place. Lessons 5 and 6 illustrate these perspectives.

Lesson 5. *School teams that promote genuine engagement of team members and other staff are more likely to produce coherent strategic and implementation plans*. The school team concept promoted by the program is certainly an improvement over

traditional approaches targeting individual teachers. Involving teachers in working groups is a relatively common practice in schools. What is difficult is to organize teams with members that are fully engaged in accomplishing common goals. Moving from mere involvement (e.g., participating in meetings, providing occasional input) to genuine engagement (e.g., contributing to important decisions, becoming an integral contributor), proved to be a challenging task for NES teams. For the most part, however, it was apparent that teams struggled in promoting engagement due to convenient selection procedures, turnover, and issues with team dynamics and communication. In contrast, as demonstrated by a few teams, it was clear that school teams with purposeful selection strategies, clear roles and responsibilities, and structures for reflection and input provided evidence of genuine engagement. In those cases, members contributed to strategic planning and were equally motivated to succeed in implementing planned activities. These teams usually remained intact throughout the year, would attend institutes together as a means to foster shared understandings, socialize to strengthen team rapport, and ensure participation in important decisions.

Since genuine engagement in interdisciplinary work is essential for productive participation in the program and—ultimately—a pre-requisite for school-wide dissemination of team efforts, it is critical that teams understand the factors that may facilitate or hinder engagement. In this context, it is also essential for teams to agree on specific roles in support of true collaboration, as opposed to relying heavily on just one person (e.g., the team leader). Further, during summer workshops, opportunities for socializing (as a means to building team rapport) and reflection (to elicit shared understandings) should be given important consideration.

Lesson 6. *Strong administrative leadership and related supports are needed to create favorable conditions for program participation and to promote greater coherent engagement*. School teams that showed greater engagement were more likely to report strong administrative leadership at least at the building level. Supportive administrative leadership found in a few teams showed administrators (e.g., principal, assistant principal) engaged in all aspects of team participation: from contributions to application preparation to organizing regular meetings with faculty to discuss participation in the NES program—and taking care of details such as bringing refreshments to create favorable conditions for engagement. In contrast, under traditional leadership structures, an appointed team leader would manage the process of writing the application and participation in the program. In such cases, administrators would be involved, but not fully engaged (see lesson 5). Further, in schools where participation in the program may be perceived as elitist, the active role of administrators is even more critical to get everyone on board.

In addition to providing leadership related to participation in the program, administrators should understand the broad programmatic implications and corresponding supports. Coherent participation of interdisciplinary teams pursuing important improvements in teaching and learning may require changes in schedules to allow team, sequential, and/or thematic teaching; common planning time; flexibility for teachers to attend conferences; support and resources to seek partnerships in the community; and empowering teachers to work on projects requiring student work beyond the classroom. The NES program should receive high marks for requiring the participation of an administrator on the teams. To make sure administrators are engaged, there should be opportunities for them during summer workshops and other venues (e.g., institutes, cohort kick-off) to develop a full

understanding of their role and strategies to support the engagement of their school teams.

Seeking Coherent External Supports

Fundamental changes in schools usually happen when improvement efforts are implemented with coherent supports for professional development, promotion of parental support, and partnerships with community groups (Newmann and Associates, 1996). This is particularly relevant in urban and rural communities with depressed economies, where students do not have appropriate roles models and emotional supports, and where schools struggle to garner community supports (Wehlage, 1993). In such places, schools need to emphasize collective action to secure opportunities for enhancing instructional capacity, leverage financial capital, and elicit social support from parents and community. External programs of professional development programs that provide coherent and sustained support where participants have input on content and delivery can be helpful in helping schools enhance instructional capacity. Networks of families with shared motivation and expectations can provide a framework of social relationships and supports for students and teachers. Concurrently, schools have been successful in securing financial supports from community groups when goals are urgent, coherent with community values, and pursued in light of potential results. Lessons 7, and 8 were identified in this context.

Lesson 7. *Proactive, planned, and coherent external professional development supports are needed to help school teams sort out what they need and maximize their participation in the program*. In general, schools seek external supports for professional development to help them achieve short- and-long term improvements. In this case, the external supports provided by the NES program are grounded in principles of effective practices. In addition to seed funding and access to educational resources, the program offers long-term support beginning with participation in summer workshops. However, the nature and structure of external professional development supports provided to school teams varied greatly across field centers for a variety of reasons. During the first year of the program, variability in quality may have developed due to the short period available for planning. As a result, summer workshops were primarily designed based on a previous model and only in a few instances was there evidence of customization to meet the priorities of affiliated school teams. Follow up on-site supports showed a similar pattern of variability. Issues related to established capacity, scheduling, and cost involved may have affected the nature and frequency of actual supports. Most importantly, at the core of overall supports is the shift from serving individual teachers and schools in short-term, single unconnected events, to organized, sustained, targeted supports to clusters of schools of teachers. This is a shift requiring drastic changes in all levels of operation and it may take time for all key parties to adjust to the new way of thinking.

In this context, it was apparent that field centers that were able to inform their design and implementation of summer workshops based on the priorities of school teams, showed greater coherence of support during and beyond workshops. Customizing supports to meet specific needs of school teams should be a high priority for field centers. Workshop agendas should also be designed around principles of adult learning to ensure genuine engagement of participants. Further, planned strategies for on-site visits should improve the quality of sustained professional development supports. Concurrently, requiring field centers to operate

differently also requires programmatic supports from headquarters. It is apparent that not all field centers operate under the same circumstances. Established capacity, existing loads, and size of area of service appear to be factors for consideration to help them help their affiliated school teams.

Lesson 8. *Promoting a network of parental and community support is essential for creating conditions to motivate and sustain student interest in science, mathematics, and technology in the context of the NES program*. Promoting family and community involvement is a key objective of the program and school teams appear to understand the importance of such connections. About half of the school teams planned some form integration of NASA educational materials for home use by students and parents. Other activities included demonstrations and thematic events (e.g., NASA Night) where parents are specifically invited. Getting parents engaged in school efforts should be a key priority for school teams, especially in areas where the economy and social conditions have eroded parental involvement. Recognizing this strategic need, the NES program has plans to strengthen this area of support with the assistance of the NASA's Science, Engineering, Mathematics and Aerospace Academy (SEMAA). SEMMA is a national program designed specifically to reach K-12 minority students that are traditionally underrepresented in careers involving science, technology, engineering, and mathematics (STEM). Through SEMAA's Family Café, the program plans to provide schools with an interactive forum featuring educational and parenting information to adult caregivers and any other supportive, adult role models. The challenge for the program is to help schools sustain and keep related efforts focused.

Similarly, the majority of schools planned community events (e.g., kick-offs) to raise related awareness, lay the groundwork for establishing community partnerships, and to seek complementary funding from businesses. The initial NES grant is not enough to support ambitious long-term plans, and schools should understand the need for additional external supports. Securing community support to establish partnerships and leverage funding is a necessary complementary strategy to ensure sustained and focused school efforts. Schools should seize the momentum and visibility generated by participation in the program as a means to leverage needed support and funding from other sources. To this end, organized visits of NASA dignitaries have been well received, as these visits appeared to have contributed greatly to related efforts.

Final Comments

The first year of the program was an exciting and challenging year. Major evaluation findings reflect the complexity of related activities as the program continues its pursuit for coherence in the short and long term. In general, the program is greatly appreciated by teachers and schools as suggested by overall feedback. At the same time, the complexity and ambitious nature of this educational undertaking reflect the challenges involved in designing and implementing reform-type efforts involving a large number of schools located in 30 states. Major findings are consistent with literature about working with interdisciplinary teams and providing coherent professional development supports. In this context, it is not surprising to have identified many areas for improvement in a large and ambitious undertaking of the nature of the NES program. To this end, emerging lessons were identified to inform future design and implementation decisions, and to make the program better in Year 2 and beyond. The fact that headquarters and field centers are already adjusting initial implementation strategies, demonstrate a dynamic evolution of the program, and mindset of helping participating schools as only NASA can.

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NES Evaluation Briefs

The Briefs in this series will provide updates on evaluation results relevant to the design, implementation, and impact of the NES program. In some instances, Briefs will feature technical issues or summarize results illustrating a design and implementation topic emerging from the evaluation.

Brief 1

This Brief outlines the overall evaluation plan including a description of design experiment strategies to document design changes over time and for establishing comparisons in terms of student achievement.

McGee, S., Hernandez, V., & Kirby, J. (2003). Evaluating the quality and impact of the NASA Explorer Schools program. *NASA Explorer Schools, Evaluation Brief 1 (NES/EB1/7-2003).* Wheeling, WV: Classroom of the Future.

Brief 2

This Brief summarizes initial evaluation data with primary focus on the summer 2003 workshops. The Brief includes a description of the 2003 school teams, their top target academic standards priorities, and evaluative feedback on the summer workshops. An analysis of the workshops is reported around a framework of effective professional development.

Hernandez, V. M., McGee, S., Kirby, J., Reese, D., & Martin, J. (2004). A program in the making: Evidence from summer 2003 workshops. *NASA Explorer Schools, Evaluation Brief 2 (NES/EB2/2-2004)*. Wheeling, WV: Classroom of the Future.

Brief 3

This Brief highlights how the program was implemented in Year 1. The Brief provides contextual information about participating schools, organizational approaches to participation, strategic planning, professional development supports, and impact on teachers and schools.

Hernandez, V. M., McGee, S., Reese, D., Kirby, J., & Martin, J. (2004). A program in the making: Findings from Year 1. *NASA Explorer Schools, Evaluation Brief 3 (NES/EB3/7-2004)*. Wheeling, WV: Classroom of the Future.

Full versions of these Briefs can be downloaded from the COTF website at: http://www.cet.edu/research/evals.html