NASA Explorer Schools
Evaluation Brief 2

A Program in the Making: Evidence from Summer 2003 Workshops

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The NASA-sponsored Classroom of the Future (COTF) program is helping to bridge the gap between America's classrooms and the expertise of NASA scientists, who have advanced the frontiers of knowledge in virtually every field of science over the last 40 years. The COTF program is administered by the Erma Ora Byrd Center for Educational Technologies® at Wheeling Jesuit University in Wheeling, WV.

The COTF serves as the National Aeronautics and Space Administration's (NASA's) premier research and development program for educational technologies. In this capacity the COTF develops and conducts research on technology-based learning materials that challenge students to solve problems by using datasets and other information resources provided by the five strategic enterprises of NASA: Aerospace Technology, Human Exploration and Development of Space, Earth Science, Space Science, and Biological and Physical Research.

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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. During the summer NES school teams kicked off the program by attending a professional development residence program lasting one week with all expenses paid at one of the 10 NASA field centers.

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. The purpose of this brief is to provide an update on program progress with primary emphasis on the summer 2003 workshops. Below is a summary of major conclusions:

- The NES program selected school teams from urban, suburban, and rural areas with substantial representation of traditionally underserved students. This would allow the program to channel resources and supports to targeted schools and teachers as called for in the NES objectives.

- A review of the top 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.

- Baseline data on perspectives and beliefs about teaching, learning, and technology suggest that NES participants are primed for professional growth through participation in the program.

- The NES program appears to be well positioned in meeting the criteria of high-quality professional development both in terms of structural and core features. However, more evidence is needed to document the quality of these features.

- Feedback provided by workshop participants on the overall NES program and workshop experiences was highly positive.

- In general, the results are both promising and tentative—promising because the program is well positioned in the target school teams and for its potential alignment with high-quality features of professional development, yet tentative because the evidence at this point is not sufficient to make definite claims about the quality of program/workshop features.

Background

The NASA Explorer Schools Program

Through the NES program middle schools from around the nation have entered into a unique three-year partnership with NASA to bring exciting opportunities to educators, students, and families through sustained professional development, exciting student learning opportunities, integration of technology, and involvement of parents.

Fifty school-based teams of five people were selected in 2003. Throughout the three-year commitment NES educator and administrator teams, working along with NASA personnel and other educational partners, will become involved in the excitement of NASA research, discoveries, and missions through participation in engaging NASA learning adventures and scientific challenges.

The 2003 NES program is focused on NASA content at the 5-8 grade levels. Materials will target appropriate, grade-specific concepts from national education standards. During the school year schools will have access to all of NASA's educational resources. In addition, schools will be supported by customized resources and events geared specifically for the Explorer Schools. These resources and events will engage students and parents in authentic activities related to NASA's unique mission.

In July 2003 NES educator/administrator teams kicked off the program by attending a professional development residence program lasting one week with all expenses paid at one of the 10 NASA field centers.

School Strategic Plans and Program Supports

Designation as a NASA Explorer School indicates an ongoing relationship with NASA through a mutual agreement for sustained involvement by educator/administrator teams in professional development and student participation in challenges and investigations. The school strategic plan informs this relationship and outlines how its implementation meets the school's local needs. The strategic plan is instrumental in outlining what programs and services NASA should provide to the school during the three-year partnership.

The strategic plan developed in the first year by each school team will outline the specific local needs relative to the six NES program objectives. The plan will also describe how the whole school (not just the NES team) will reorganize to address these local needs. The schools will receive grants of up to $10,000 to assist with the implementation of the strategic plan. Each NES team member will receive a $500 stipend for implementing the team's strategic plan during the 2004-2005 school year. The schools will submit progress reports on their strategic plan and provide feedback to the evaluation team via video or phone conference focus groups.

During the summer 2003 workshop the team learned about NASA content, resources, and programs. The teams also began to develop their strategic plan to meet their specific needs. The teams further refined strategic plans during fall 2003. The final strategic plan and application for grant funds were submitted to NASA in October 2003. NASA and other educational partners will work with the school to implement the strategic plan for the remainder of the three-year partnership.

NES Program Objectives

While the NASA education programs have enjoyed wide-scale success for decades, the NES program represents a significant reorganization of NASA's education offerings and school supports. NASA's organizational focus for the NES program is to create a structure within which previously independent programs will be integrated around a common set of objectives. This integration will benefit from NASA's decentralized management structure. Each NASA field center will uniquely organize its local resources to meet the needs of the five schools it is supporting. In turn, each of the 50 school teams will uniquely organize its local resources and take advantage of NASA resources to address the NES program objectives. Under this organizational design the objectives of the NES program seek 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.

While a variety of programs across the nation share similar objectives, the NES program addresses these objectives in a way that only NASA can. The contribution of NASA-unique opportunities to the NES program will provide a measurable impact on the NES objectives that goes beyond the impact of other programs available to typical schools located in the same region as the Explorer Schools.

NES Evaluation Plan

The core evaluation question is focused on whether participation in the NES program leads to accomplishment of the program objectives. A key objective 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 information will be fed back to the program participants and NASA education personnel to inform their design decisions throughout the program. This second report in the NES Evaluation Briefs series is the first to provide formative information about activities conducted during the first year of the program.[1]

The evaluation is guided by a hybrid evaluation design. The process of documenting design decisions and using evaluation information to inform design decisions is the hallmark of a recent advancement of educational research called design experiment (Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Shauble, 2003). The design experiment approach is focused on the schools participating in the NES program. By

[1] For a detailed description of the overall evaluation plan, see NES Evaluation Brief 1 (McGee, Hernandez, & Kirby, 2003).

explicitly linking the design rationale with the objectives, the design experiment approach moves beyond mere formative assessment. A design experiment provides evidence on both whether a program works and why it works. The design experiment methodology will be combined with a scientific-based research (SBR) methodology to compare a given implementation year to a comparison group to measure the effect of the program for a given year. The What Works Clearinghouse Study Design and Implementation Assessment Device will guide the design of comparative studies of program effectiveness.

Design Experiment Data Collection

The primary means of documenting the design of the program at each field center and at each school is through the formal design documents produced by each organization. Strategic plans and progress reports produced by field centers and enterprises will be documented to determine the nature and extent of school supports and how they organize resources, events, and personnel to meet each of the six objectives. The evaluation team will complement these strategies with site visits at selected NASA workshops and videoconference focus groups with field center personnel. To document the design and implementation of summer workshops, reviews of related materials and any internal planning documents will be conducted. Through the focus group the evaluation team will discuss how NASA resources are being used and clarify outstanding issues within the strategic plans. The evaluation team will also document the use of NASA's extensive online resources by the Explorer Schools.

Data from NASA's evaluation database, NEEIS, serves as the basis for documenting participant perceptions of the NES program activities. To this end, strategic plans and implementation reports will be accessed through NEEIS.

Scientifically Based Research Data Collection

Working with NASA field center program staff, SBR data collection will include identification of existing measures or the development of new measures of each of the six program objectives. For objective one related to student learning, a combination of state assessment data as well as the collection of new assessment data from existing test banks of high-quality items will be used. For objectives two and three related to knowledge of careers and student interest, existing career awareness and interest surveys will be customized. For objective four and six related to teacher professional growth and increased technology use by schools with underserved students, an adapted version of the Teaching, Learning, and Computing survey will be used. For objective five related to family involvement, existing metrics of family involvement will be customized.

All measures will be collected in NES schools at each of the targeted (4th-9th) grade levels. We will also identify and use relevant state data available through the state information systems. The unit of analysis will be the school level. Performance of Explorer Schools will be compared to performance at comparison schools.

Evaluation Advisory Committee

An advisory group for the scientifically based research component will provide input on the evaluation design and implementation. The committee includes scholars who have made substantial contributions to the body of knowledge in areas relevant to the evaluation of the NES program. The list of committee members is provided in Table 1.

Table 1. Membership of evaluation advisory committee.	
Dr. Corinne J. Alfeld, deputy director National Research Center for Career and Technical Education, University of Minnesota	Dr. Malcolm V. Phelps, director Research and Evaluation NASA Headquarters
Dr. Shelley Canright, program executive Technology and Products Program Office NASA Headquarters	Dr. John J. Smithson, research associate Wisconsin Center for Education Research School of Education, University of Wisconsin-Madison
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Dr. Dan Hickey, research scientist Learning and Performance Support Laboratory, College of Education, University of Georgia	Dr. Frances Van Voorhis, consultant Center on School, Family, and Community Partnerships, Johns Hopkins University
Dr. Margaret Honey, vice president Education Development Center Director, Center for Children and Technology	Dr. Edward W. Wolfe, assistant professor Measurement and Quantitative Methods College of Education, Michigan State University

Evaluation of Summer 2003 Workshops

The evaluation of summer 2003 workshops was conducted under the framework of the overall evaluation. The primary purpose of the evaluation was to document the design and implementation of summer workshops. This report also summarizes demographic data about the overall pool of selected school teams, their targeted focus in terms of academic standards, and background information about collective perspectives and beliefs on teaching, learning, and technology to set the baseline context for future reference and analyses.

About the Summer Workshops

School teams attended a professional development residence program lasting one week with all expenses paid at one of the 10 NASA field centers in summer 2003. Each center designed and delivered a one-week workshop for the five school teams selected from its service area and involving a combined total of 25 participants. Team members received a $500 stipend for their attendance and the opportunity to earn graduate or professional development credit. Center location, working focus, and regional service area is presented in Table 2. In general, the summer workshops focused on the following activities:

- Engage in grade appropriate, NASA Enterprise-related, hands-on/minds-on activities.
- Learn how to use technology tools to support classroom investigations.
- Work cooperatively with other team members to prepare a strategic plan to address local needs in science, mathematics, or technology education.

- Design a customized professional development plan to support the implementation of the local action plan, using distance learning and identified state content experts.

- Discover new avenues for collaborative learning through advanced educational technologies and strategies.

- Strengthen and increase knowledge about problem-based learning and the inquiry process.

- Explore NASA educational materials and develop a strategic plan to support their incorporation in local/state curricular needs.

- Learn real-world and practical applications of science, technology, engineering, and mathematics (STEM) and geography from NASA scientists, researchers, and engineers in NASA applied research facilities.

Table 2. Location, service area, and focus of NASA field centers.

Field Center	Service Area	Focus
Ames Research Center, California	AK, Northern CA, HI, ID, MT, NV, OR, UT, WA, WY	Information technology, astrobiology (the study of the origin, evolution, and distribution of life in the universe) and aviation operations, capacity, and safety issues
Dryden Flight Research Center, California	AZ, Southern CA	Breakthrough technology and scientific advances through flight research and concept validation
Glenn Research Center at Lewis Field, Ohio	IL, IN, MI, MN, OH, WI	Aeropropulsion technologies, aerospace power, microgravity science, electric propulsion, and communications technologies for aeronautics, space, and aerospace applications
Goddard Space Flight Center, Maryland	CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT	Earth and space science (including climate change and ozone research), astronomy (including the Hubble Space Telescope and Compton Gamma Ray Observatory), solar physics
Jet Propulsion Laboratory, California	CA	Planetary science and exploration
Johnson Space Center, Texas	CO, KS, NE, NM, ND, OK, SD, TX	Human space flight, space shuttle missions, space station, mission control, lunar samples
Kennedy Space Center, Florida	FL, GA, PR, VI	Spaceport operations, spaceport design and systems development, and spaceport and range technology and science.
Langley Research Center, Virginia	KY, NC, SC, VA, WV	Aviation safety, quiet aircraft technology, small aircraft transportation, and aerospace vehicles system technology
Marshall Space Flight Research Center, Alabama	AL, AR, IA, LA, MO, TN	Advanced X-Ray Astronomy Facility, space shuttle main engines, the Spacelab program, and microgravity research.
Stennis Space Center, Mississippi	MS	Space shuttle main engine testing, geographic information systems, small spacecraft technology, commercial remote sensing. testing and flight certifying rocket propulsion systems

Evaluation Approach

A series of guiding questions were developed to inform the evaluation of summer 2003 workshops. The questions were intended to document work completed through August 2003 and related to specific NES objectives. This alignment is presented in Table 3.

Table 3. Alignment of evaluation questions and NES objectives.

Guiding Evaluation Question	NES Objectives
1. What is the profile of schools designated as NASA Explorer Schools?	Objective 6: Increase the academic assistance for and technology use by educators in schools with high populations of underserved students.
2. What are the top target standards of selected schools?	Objective 1: Increase student ability to apply science, mathematics, and technology concepts. Objective 2: Increase student knowledge about careers in science, mathematics, and technology. Objective 3: Increase student interest in and participation in science, mathematics, and technology.
3. What are the participants' perspectives and beliefs about teaching, learning, and technology?	Objective 4: Increase the active participation and professional growth of educators in science, mathematics, and technology.
4. Who participated in summer 2003 workshops and what did they do?	Objective 4: Increase the active participation and professional growth of educators in science, mathematics, and technology. Objective 6: Increase the academic assistance for and technology use by educators in schools with high populations of underserved students.
5. What was the participants' feedback on summer workshops?	Objective 4: Increase the active participation and professional growth of educators in science, mathematics, and technology.

Data Collection Strategies

Data collection strategies for question 1 involved a review of applications materials to document demographic information. For question 2 a survey designed by NES staff gathered information about priorities for school teams in terms of academic standards used to identify top targeted science, mathematics, geography, and technology standards. Upon selection all program participants were required to complete this survey.

For question 3 all participants were required to complete the Teaching, Learning, and Computing (TLC) online survey. The TLC was created by Jay Becker of the University of California-Irvine and Ronald E. Anderson of the University of Minnesota (Becker, 2000), with support from the National Science Foundation and the U.S. Department of Education's Office of Educational Research and Improvement. The TLC is a self-report questionnaire that measures teaching practice, teaching beliefs, technology use in the classroom, and teacher professionalism. The original version, used in a national survey that assessed 4,100 teachers, was made up of 21 pages that took approximately 60-75 minutes to complete. 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). For this evaluation four versions of the TLC were combined into one questionnaire, taking less than 60 minutes to complete. 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).

Data collection strategies for question 4 consisted of two components. First, NEEIS data was used to profile overall participation in summer workshops. Second, summer workshop agendas were collected to gather data on important factors associated with effective professional development. Finally, for question 5 NEEIS data was used to document the evaluative perspectives of participants on key elements of summer workshops.

Analysis

The purpose of this evaluation was to document and describe baseline trends with primary focus on the summer 2003 workshops. Overall, descriptive analyses were used to summarize data for this report. In selected cases t-tests were used to determine differences (e.g., TLC survey data). A framework for effective professional development (Garet, Porter, Desimone, Birman, & Suk Yoon, 2001) guided the analysis of workshop experiences. This framework is based on two dimensions (structural and core features) and is presented in Table 4.

Table 4. Features of effective professional development.

Structural Features	Core Features
Type of Activity ▪ Whether the workshops focused on traditional (e.g., participants attend sessions at scheduled times) or reform type 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.	**Opportunities for Active Learning** ▪ Whether participants had opportunities to practice under simulated conditions, received feedback, met formally and/or informally with others to discuss classroom implementation, developed curricula or lesson plans, reviewed student work, and presented or led 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, aligned with academic standards, and had potential for sustaining and extending what is learned to other teachers. That is, the extent to which workshops and team efforts align to support a coherent program of teacher learning and development.

Structural features (i.e., type of activity, duration of the activity, type of participation) were analyzed based on the implicit design of the NES program. Two of the core features (content focus, opportunities for active learning) were analyzed based on the time spent in related activities. The analysis of the core feature related to coherence was beyond the scope of this report. To determine the extent to which workshops and team efforts align to support a coherent program of teacher learning and development requires a long-term perspective that will unfold throughout the three-year participation of the teachers.

Using workshop agendas as the basis for the analysis, a team of two researchers conducted an initial review of the agendas. Preliminary results were shared with field center staff during a retreat in fall 2003. With input from field center staff, the definition of core features was clarified. To ensure the accuracy of the analysis, the research and evaluation team requested field center staffs to review, verify, and/or recode summer workshop agendas.

Findings

The presentation of findings is organized around the guiding evaluation questions for the 2003 summer workshops. First, a brief description of the overall participation in the NES program is provided to set the context for this report. Next, we present a summary of top academic standards identified by NES school teams as targeted priorities. This is followed by an analysis of baseline Teaching, Learning, and Computing survey data, and by a description of participation in summer workshops and focus of professional development activities. Finally, a summary of evaluative perspectives based on NEEIS data is presented.

What Is the Profile of NES Designated Schools?

Based on selected demographic indicators, having school teams designated as NASA Explorer Schools clearly puts the program in a position to support work related to Objective 6 (increase the academic assistance for and technology use by educators in schools with high populations of underserved students).

A total of 430 applications were submitted for consideration to participate in the NES program. Of these, 50 school teams were selected, representing 30 states; 61 schools; 250 educators, including teachers and administrators; and 35,220 students. Some school teams represent partnership between an elementary, middle, or high school or any combination thereof based on their particular school composition and local needs.

The typical school team includes an administrator (decision maker who serves as a change agent within the school) who will work with and empower the team and 3-4 full-time classroom educators who provide regular or special education instruction in science, mathematics, or technology at the 5-8 grade level. Also, the 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 Explorer School team. A key requirement is that all teachers on the team must be certified/licensed by their state department of education and have a minimum of three years of teaching experience.Considering all school teams, 58 percent of the teams can be identified as high-poverty, high-minority schools. Further, 62 percent of the participating schools are located in high-poverty areas and typically report more than 50 percent minority enrollment annually.[2] In terms of location, 46 percent of the school teams are located in urban areas, 10 percent in suburban locations, and 44 percent in rural communities.

What Are the Top Target Academic Standards of NES Participants?

Once school teams were selected, it was important for NES staff to determine what the school teams were trying to accomplish through their participation in the NES program and gauge the alignment with two key NES objectives: Objective 1 (increase student ability to apply science, mathematics, and technology concepts), and Objective 2 (increase student interest in and participation in science, mathematics, and technology). This was achieved by asking school teams to identify their top target academic standards. A review of the top priorities related to science, mathematics, geography, and educational technology indicated a close alignment with the two academic objectives of the NES program. 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.

Science and Geography Standards

Upon review of the top academic standards, science and geography priorities were grouped together given their high degree of affinity in the context of NASA's work and educational resources. The national science education standards (grades 5-8), and the national geography standards served as the basis for identification of top priorities. Science priorities included three physical science standards, two Earth and space science standards, and one life science standard (see Table 5). Concurrently, only one geography standard was identified as a top priority. Concepts of interest involved motions and forces, properties of matter, and energy, which could serve as the basis for understanding other concepts of interest, such as Earth in the solar system and structure of the Earth system. These concepts along with populations and ecosystems represent an excellent match to the core of NASA's work and the emphasis of its educational resources (see Table 2). Similarly, the geography standard about the world in spatial terms is at the core of NASA's understanding of navigation and mapping systems and the interface with technologies to process, interpret, and report relevant information.

Table 5. Top targeted science and geography standards.

Science Standards
Physical Science ▪ Motions and forces (43%) ▪ Properties and changes of property matters (33%) ▪ Transfer of energy (31%)
Earth and Space Science ▪ Earth in the solar system (45%) ▪ Structure of the Earth system (31%)
Life Science ▪ Populations and ecosystems (33%)
Geography Standards
The World in Spatial Terms (41%) • How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information

[2] High-poverty schools are schools with large concentrations of low-income students. Usually a school is considered high poverty if between 35 percent and 100 percent of its students come from low-income families—which are usually defined by whether or not they are eligible for free or reduced lunches (Brown, 2003).

Mathematics Standards

The principles and standards for school mathematics (grades 6-8), served as the source for identification of top priorities. A significant number of NES participants identified two middle school mathematics standards as top priority: data analysis and probability (31 percent) and problem solving (37 percent). The standard of data analysis and probability is about the formulation of questions that can be addressed with data and the collection, organization, and display of relevant data to answer them. Problem solving calls for the application and adaptation of a variety of appropriate strategies to solve problems. The common denominator is a focus on conducting investigations as scientists answer questions and problems that matter and are relevant to students. Clearly, these standards hit the essential nature of NASA's work and provide rich ground for alignment with its educational resources.

Educational Technology Standards

NES participants were asked to identify top priorities for educational technology standards based on two sources: standards for technological literacy and national educational technology standards. The design standard was clearly identified as a top priority on both sources at similar rates (39 percent based on standards for technological literacy and 35 percent based on the national educational technology standards). Although this standard shares the same label, its emphasis differs depending on the source. The standards for technological literacy call for the development of student understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. From the national educational technology standards perspective, the goal of the design standard is to develop, publish, and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom.

NES participants also identified a second standard from the national educational technology standards as a top priority. The standard related to collaboration was chosen by 41 percent of NES participants. The emphasis of this standard is for students to collaborate with peers, experts, and others using telecommunications and collaborative tools to investigate curriculum-related problems, issues, and information and to develop solutions or products for audiences inside and outside the classroom.

What Are the Initial Perspectives on Instructional Practices?

The Teaching, Learning, and Computing Teacher’s Survey (Becker, 2000) is a self-report questionnaire that yields data on five constructs aligned with constructivist principles for teaching and learning. Constructivist ideas have emerged from recent research about how the human brain works and what is known about how learning occurs. Constructivist principles predicate teaching and learning based on the premise that learning is about knowledge construction rather than reproduction. To this end, students learn by building upon what they already know. Constructivism is grounded 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).

The scale used to gauge constructivist perspectives and beliefs ranged from 1 (very traditional) to 5 (very constructivist). A one-sample t-test of the means was conducted to determine differences in comparison to the midpoint (3 = transitional). The results are presented in Table 6.

Initial constructivist uses of technology showed significant differences indicating that participants are somewhat limited in their use of technology to support constructivist learning. Constructivist teaching strategies were reported at the transitional level suggesting participants' motivation to improve teaching practices through participation in the NES program. Constructivist teaching philosophy and technical skills were significantly different from the transitional point suggesting that participants are somewhat open to constructivist ideas and somewhat comfortable with technology skills. At the same time, participants showed a relatively high attitude toward technology, which reinforces the potential underlying motivation to participate in the NES program.

Table 6. Indicators of constructivist perspectives.

Variable	N	Mean	Standard Deviation
Constructivist Uses of Technology	115	2.53**	.883
Constructivist Teaching Philosophy	127	3.72**	.517
Constructivist Teaching Strategies	115	3.11	.652
Technical Skill	119	3.32**	.687
Attitude Toward Technology	120	4.12**	.555
**Test value = 3, p <.001			

Who Participated and What Did They Get from the Experience?

The analysis of the summer workshops had two components. First, demographic indicators were summarized to profile participation. Second, the focus of the workshops was analyzed to describe the nature of the professional development activities provided to NES participants.

Indicators of Participation

Data collected from 222 participants (89 percent of all NES participants) indicated a prominent representation of females (72 percent) compared to males (28 percent). The common denominator across all participants (100 percent) was the underlying motivation to participate (to increase knowledge of science, technology, engineering, and math and/or geography), which was in direct alignment with top targeted academic standards identified by NES participants. As Table 7 shows, the majority of workshops participants were of Caucasian descent (72 percent) followed by a large group of African-American educators (18 percent). Other minority groups accounted for only 10 percent of overall participation. The majority of participants reported a master's degree (60 percent), while about a third declared to hold a baccalaureate degree. Further, a third of all workshop participants reported teaching all subjects, while 28 percent indicated teaching general science. As expected, those who teach in particular areas of instruction (Earth science, life sciences, mathematics, physical science)

Table 7. Demographic indicators.

Ethnicity	
72%	Caucasian/White
18%	African American/Black
10%	Other: Asian, Hispanic, Native American, Pacific Islander
Education	
60%	Master's degree
35%	Baccalaureate degree
5%	Other: associate degree, doctorate
Areas of Instruction (15% and greater)	
33%	All subjects
28%	General science
19%	Earth science
19%	Life sciences
17%	Mathematics
15%	Physical science

were represented at lower and comparable rates ranging between 15-19 percent. Collectively, areas of instruction appear to support the choice of top target academic standards.

Structural Features of Workshops

The analysis of structural features (type of activity, duration of the activity, and type of participation) was based on categories identified by Garet and associates (2001).

Type of activity. According to Garet and colleagues, traditional forms of professional development activities include within-district workshops, course for college credit, out-of-district workshops, and out-of-district conferences. Reform type of activities include teacher study groups, teacher collaboratives or networks, committees, mentoring, internships, and resource centers. Taking in isolation, the workshops appeared to share some traditional elements across the board (e.g., participants attend sessions at scheduled times). However, in the context of the three-year commitment of the NES program, focus on school teams, and commitment for continued support, the workshops clearly fall into the reform type. This is further reinforced by its emphasis on teacher collaboration, networking approaches, study groups, use of resource centers (e.g., field center support, NASA products/resources), and follow-up professional development activities that may happen anytime during the following school years.

Duration of the activity. To characterize duration of professional development activities, we evaluated two aspects of duration: the total number of contact hours and the period of time in days. Research indicates that longer and extended professional development activities allow for more thoughtful discussions of content and pedagogical strategies. Concurrently, whether professional development activities are extended over time or are short and terminal with no follow-up would hinder or facilitate teacher growth. In the context of a three-year commitment, all workshops were conducted over a full week with expected follow-up support by field center staffs and subsequent professional development to be arranged by the participants (e.g., attendance at fall and spring conferences). By comparison the trend reported for span of traditional activities is 2-4 days, and nine months or more for reform-type activities. Further, the number of contact hours for NES workshops ranged from 34 to 77, with an average of 43 hours. The range suggests a wide variability in duration across field centers. The average duration, on the other hand, suggests an intense immersion in workshop activities when compared to the average number of contact hours for reform-type activities (35 hours) and traditional activities (23 hours) documented in related literature (Garet et al., 2001).

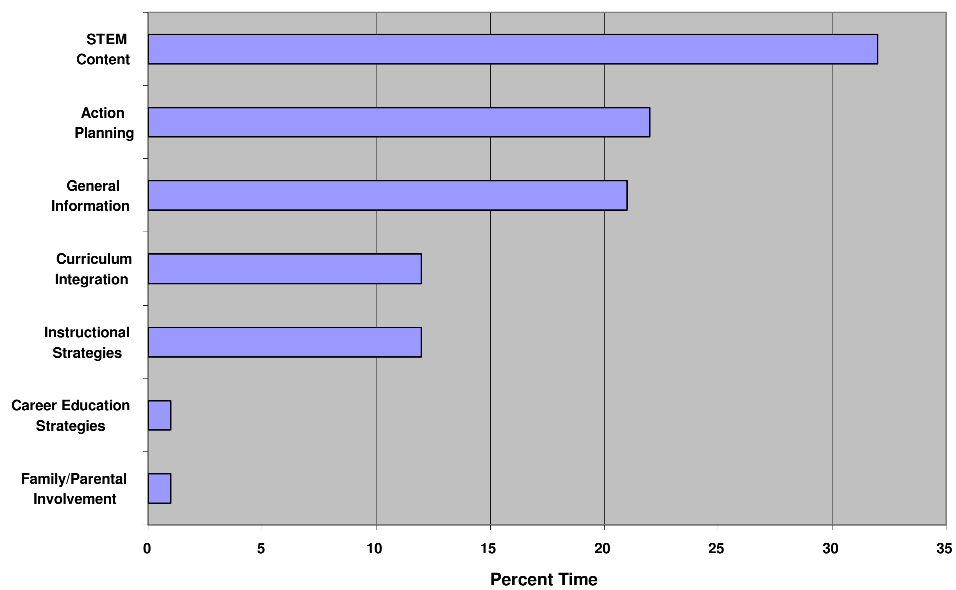
Type of participation. The literature on professional development documents the benefits of activities designed for groups of teachers from the same school, department, or grade level. Teachers who are provided with opportunities to work together are more likely to report more productive experiences (Newmann & Associates, 1996; Talbert & McLaughlin, 1993). In this case it was important to determine 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. This is a feature where the NES program is particularly strong. Central to its design, the NES program calls for participation of school teams focusing on middle grades and with particular emphasis on science, mathematics, geography, and technology curricula. A staple expectation is for school teams to work together over a three-year period, serving as the nucleus for sharing ideas and extending efforts schoolwide. Under this design the workshops provided initial opportunities for school teams to develop/refine strategic plans, identify resources needed, and think about further individual and team professional development.

Core Features of Workshops

Using workshop agendas as the basis for analysis, three core features found to be indicators of effective professional development were examined. These features included content focus, opportunities for active learning, and coherence with other activities (Garet et al., 2001).

Content Focus. Recent research suggests that content covered in professional development activities varies greatly in terms of focus on content knowledge, teaching practices, what skills students should learn, and about how students learn (Garet et al., 2001). In this context, a key decision for improving the efficacy of professional development activities is to determine the balance in content focus. In this evaluation the content focus was determined through an analysis of two aspects: time spent on specific activities and time spent using NASA products/resources. The percentage of time spent on each of these activities is presented in Figure 1.

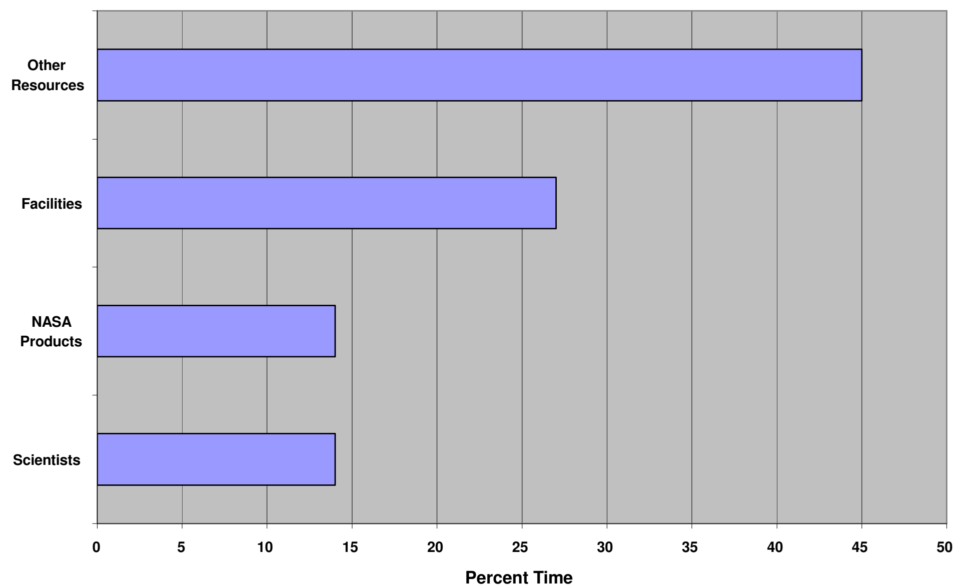
Figure 1. Percent time spent on specific activities



First, we analyzed the time spent on subject matter content with particular interest in science, technology, engineering, and mathematics (STEM) content; instructional strategies; curriculum integration; strategies for family/parental involvement; and career education strategies. Concurrently, we analyzed the time spent on general informational activities (e.g., orientation, center tours, time to complete travel and evaluation forms) and action planning. Overall, three levels of emphasis were observed across the workshops: high, moderate, and low. The workshops highly emphasized STEM content (32 percent), action planning (22 percent), and general information activities (21 percent). Of secondary interest were curriculum integration (12 percent) and instructional strategies (12 percent), while little attention was given to career education and family/parental involvement strategies. Apparently, the design strategy was primarily twofold: (a) to provide as much content coverage as possible, to allow school teams to develop and/or refine strategic plans, and to provide participants with information about NASA and field center resources; and (b) to show some connections to curriculum and instruction.

In this context we also analyzed the time spent using NASA products (e.g., curriculum supplements). Figure 2 shows the time spent on formal and informal presentations by NASA scientists, using NASA curriculum materials, exposure to center facilities, and using a variety of other noncurricular resources (e.g., simulation tools, technology development processes).

Figure 2. Percent time spent on NASA products/resources



Clearly, for the most part participants were exposed to a wide variety of noncurricular NASA resources (45 percent of the time) and familiarizing with field center capabilities and facilities (27 percent). The rest of the time (28 percent) was equally divided using NASA curriculum products (e.g., Signals of Spring), and on presentations or demonstrations conducted by center scientists. Regarding use of NASA curriculum products, a list of approved products suited for use in the NES program was developed with input from each of NASA's scientific enterprises. Because of limitations in identifying related information in workshop agendas, related materials were broadly defined to include a wide range of NASA-related resources. Nonetheless, related specific use was relatively low.

<u>Opportunities for Active Learning</u>. The benefits of active learning on teacher growth have been documented in the context of professional development (Schifter, 1996). Teachers who have the opportunity to practice under simulated conditions, experience curriculum development activities, and engage in focused discussions with others about implications for classroom implementation are more likely to report professional growth (Garet et al., 2001). In general, workshop participants spent more than half of the time (58 percent) in professional development activities requiring active learning and involving work on strategic plans. For example, teams participating in the workshop organized by Goddard Space Flight Center used

technological parameters of satellites, satellite tools, and data collection to simulate a remote sensing program implementation. The teams used this information to generate ideas about the use of real-world data and analyses and generate ideas for using other data sets in the classroom. To this end, across all workshops participants were afforded daily opportunities to meet as a team and work on strategic plans (22 percent of the time).

What Were the Participants' Perspectives on Summer Workshops?

Based on NEEIS data, an analysis of the participants' perspectives on the content and quality of professional experiences was conducted. What follows is a descriptive summary of perspectives on how participants viewed the workshops, what they learned, potential impact, and how they rated overall quality.

Overall Impressions

To get a sense of the overall impressions about the workshops, participants were asked to choose all applicable qualifiers from a set of 24 terms. Term selection ranged from 0 (unnecessary) to 86 percent (rewarding, valuable). Table 8 presents terms that were selected by at least half of the participants. Clearly, positive terms associated with pragmatic, content focus, and affective dimensions suggest the majority of the participants viewed the workshops as a positive and rewarding experience. Terms selected in the 80 percent bracket signaled appreciation for the practical value of the workshop, while terms chosen in the 70 percent bracket suggest participants were satisfied with the supportive environment of the workshops. Further, qualifiers chosen in the 60 percent bracket appear to address the nature of the content underlying the workshops. By comparison, terms with relative connotations of dissatisfaction or concerns (unnecessary, difficult, easy, too long) were by far scattered and chosen by only a few of the participants (range from 0 to 7 percent).

Table 8. Percentage of qualifiers selected by participants.

Area	Qualifier	Percentage
Pragmatic	Rewarding	86
	Valuable	86
	Worthwhile	83
	Growing experience	82
	Helpful	81
	Inspiring	81
Affective	Enjoyable	79
	Supportive	71
Content Focus	Challenging	68
	Insightful	68
	Comprehensive	67
	Innovative	67

Perceived Benefits

The benefits of participation were analyzed based on responses to NEEIS questions related to understanding of NASA's role in education, gains in awareness and interest in specific content, aspects of the workshops deemed as valuable by participants, and perceived impact of workshop participation.

<u>Understanding of NASA's Role in Education</u>. As indicated by data on content focus, a primary emphasis of the workshops was to expose participants to the wide array of NASA's curriculum products and resources. The goal was to put the participants in a position to develop a better understanding of NASA's role and resources as a means to inform their participation in the NES program and refine strategic plans accordingly. To this end, when asked to report their level of agreement with 12 related statements (from 1 = strongly disagree to 5 = strongly agree), the average

rating was 4.6. Statements that received a rating recognized as exemplary (4.7 or higher average rating) included appreciation for using NASA resources to offer the NES program (4.9 average rating) and better understanding of NASA's mission and support for education (4.8 average rating). As a result, participants reported they learned more about careers related to NASA (4.7 average rating).

Gains in Awareness and Interest. Specific gains in appreciation for and interest in particular subject areas is presented in Table 9. Average ratings were based on a 5-point Likert scale ranging from 1 (very low) to 5 (very high) scores indicating level of appreciation and/or interest. The greatest average gain in appreciation and/or interest level was observed in the area of engineering followed by geography, technology, and science. This is perhaps partially explained by the fact that participants were greatly exposed to NASA's curriculum products, resources, and facilities connected to a number of applications in the context of engineering, geography, technology, and science concepts and processes. The discovery of "new" information appeared to be stronger in engineering, which might explain the higher average gain. Appreciation for mathematics registered a marginal average gain. We speculate that this may be attributed to a peripheral emphasis in related content and the usual invisibility of mathematics when demonstrations of technology and engineering applications are conducted.

Table 9. Average ratings before/after participation in summer workshop.

Area	Before	After	Gain
Engineering	2.6	3.5	+1.0
Geography	3.1	3.8	+0.7
Technology	3.7	4.4	+0.7
Science	3.8	4.4	+0.6
Mathematics	3.4	3.8	+0.4

Most Useful Aspects of Workshops. Open-ended commentary provided by workshop participants was sorted by categories and tallied to determine the extent of prevalence across workshops. Overall, open commentary touched on many ideas and only a few categories had some level of resonance among participants. Table 10 presents results on selected categories.

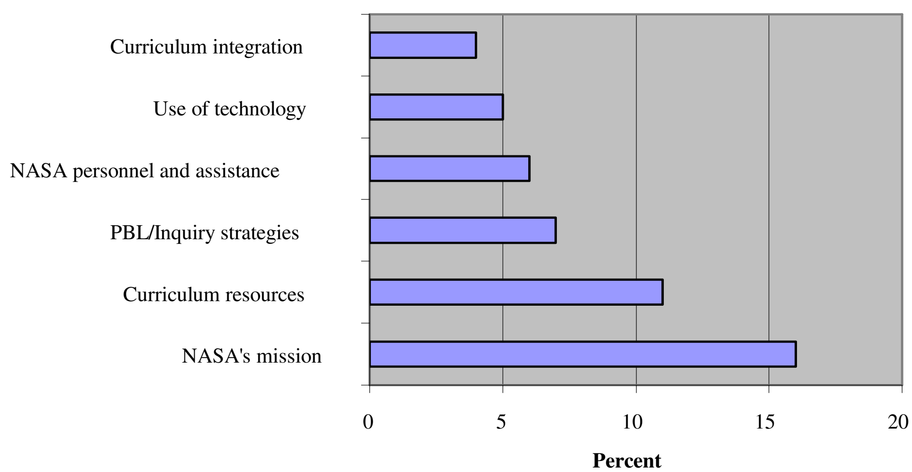
Not surprisingly, workshop participants were appreciative of the opportunity for exposure to NASA's resources and facilities. About 16 percent of the participants commented on their greater understanding of NASA's mission and its contribution to educational efforts to improve teaching and learning in math, science, engineering, and technology. The following comment summarizes this perspective:

> "Understanding the NASA mission statement and that there is a lot more to NASA than space exploration and how easily it can be incorporated into a wide range of disciplines. [Our school connection with NASA will bring about] a positive press for our school and maybe a way to help kids in a poor rural area understand some of the possibilities available to them."

Concurrently, about 11 percent indicated they came out of the workshops with a better understanding of the wide variety of curriculum products and resources that may be available to them. For example, one of the participants provided the following comment:

"Benefits! The resources available are number one, both in terms of speakers (expertise) and materials. What a great source for us to have in order to share with our students. The networking we were able to create along with the sharing with other schools was the next best thing and the wealth of information we gain (knowledge) as individuals—it all contributes to inspiring and motivating me as a teacher and learner as only NASA can!"

Table 10. Aspects of the workshops found useful by participants.



To a lesser extent, other areas mentioned by participants as being particularly useful included problem-/inquiry-based teaching strategies, specific NASA personnel and assistance, use of technology, and curriculum integration strategies.

Perspectives on Potential Impact. Two NEEIS questions were used to gauge participants' perspectives on the impact of program participation. One related to impact on knowledge and skills, the other related to anticipated changes compared to prior teaching practices. The rating scale ranged from 1 (negative impact) to 5 (great impact). Participants responded to six statements on knowledge and skills and average ratings ranged from some to great impact (4.5 to 4.9). The same pattern of average ratings was observed for responses on eight statements on anticipated changes (4.1 to 4.8). Table 11 shows statements rated 4.7 and higher, which signal "great impact" level. It is important to note that responses appear to take into consideration overall potential impact of the NES program beyond participation in individual summer workshops.

Table 11. Average ratings on statements about program impact.

Program Impact on Use of Knowledge and Skills	
▪ Will inspire my students	4.9
▪ The application of science, technology, engineering, mathematics, and/or geography	4.8
▪ Integration of career education about science, technology, engineering, mathematics, and/or geography	4.7
Anticipated Changes as a Result of Participation	
▪ Using NASA resources to enhance my instruction	4.7

Clearly, participants expect an impact on their students. Participation in the NES program is expected to be the source of ideas for improvements in teaching and learning, and—ultimately—the source of inspiration for students. The use of NASA resources to enhance instructional practice is seen as the primary vehicle for improvements in curriculum integration and student motivation**.**

Overall Evaluative Perspectives

Responses to NEEIS questions requiring the evaluation of the workshop as a whole and rating of specific components yielded very positive feedback from workshop participants. Overall satisfaction was determined through responses to six statements based on a rating scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Average ratings ranged from 4.5 to 4.8. In general, participants strongly agreed that the program was a valuable experience, NASA-related materials provided in the workshop can be integrated in the school's curriculum, they expect to apply what they learned in the program, and they were satisfied with the job done by the presenters.

Likewise, the average ratings of four statements related to program content and leaders were very positive. Table 12 presents average ratings based on a 5-point Likert scale (1 = very poor, 5 = excellent). Average ratings for all statements leaned toward the excellent level and signaled a high level of satisfaction with specific components of the workshop and the NES program at this point. In general, participants would highly recommend other teachers to participate in the program.

Table 12. Average rating of program, content, and leaders.

What kind of recommendation would you give to someone who asked you about applying to this program?	4.9
Rating of program content	4.8
Rating of the program	4.8
Rating of program leaders	4.7

Suggestions for Improvement. Based on open commentary, it was possible to identify specific areas that may require improvement. Comments from all workshops were sorted in categories and summarized in aggregated form. In general, three issues emerged from participants' feedback. One issue related to schedule changes, the other was about length, and the third—to a lesser extent—was concerned with computer access during the workshops (see Table 13).

About 15 percent of the participants called for changes in schedule. Suggested changes ranged from more time for group planning to reexamining the value and/or delivery process of specific sessions. In some cases specific suggestions were provided. For example:

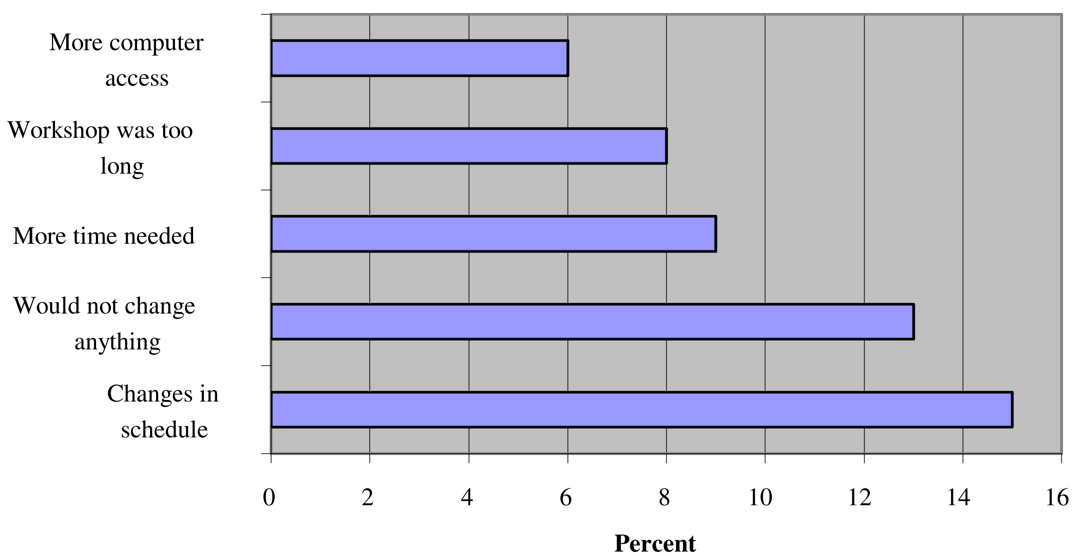
> "I enjoyed all of the NASA activities. The only thing I would suggest changing is having a little more work time set up each day for group planning of the action plans. For teachers it is very nerve-racking to have to wait until the last day to complete activities (that's when we had the most time to finish up).
>
> "The materials, web sites, posters, etc., are all extremely valuable, and I appreciate gaining access to them. However, the time spent on site at NASA is not of the quality I expect. This is my second NASA workshop, and I

experienced the same phenomenon at the first one. The information that I can take away and use myself is excellent, but the process of acquiring it needs improvement."

"Possible revision and streamlining agenda [for] more interactive sessions."

"I would set the workshop up as a PBL. 'What would I like my school to look like, and how can NASA help it get there?' Here, the first two questions, 'What we know' are easy. Then, when we have to discover what is possible (for instance in technology) and 'What can NASA do for us?' This could lead to searching the web, the ERC, et al. You would model inquiry as the natural way of doing things."

Table 13. Percentage of participants identifying specific areas that may need improvement.



Although some participants called for changes in scheduling, a relatively similar group in size (13 percent) expressed a general satisfaction with the design and schedule of the workshops. To them, no changes were necessary.

Regarding changes in length, a similar trend was observed. While some participants (9 percent) indicated the workshop needed more time, a group in comparable size (8 percent) indicated the opposite: The workshop was too long. Either way, there appears to be an underlying call for revising the schedule/length of the workshop. Finally, another issue that resonated somewhat across workshop participants (6 percent) was the need for greater and/or more convenient access to computers given the intensity of the schedule. The call for greater access was at both the workshop site and the hotel to facilitate work on action plans. Below is a sample of related comments:

"I would hope in future programs that you would allow for more time for discussion among schools at the session. Even though we were in rooms with other team members from schools other than our own, there was no time for reflection as to what we were doing. We were busy after the day's events working on our action plans. I also would hope that maybe there could be more assistance in working with the groups and their action plans. Teachers when allowed to interact can come up with some awesome plans and ideas. I think with more interaction among teams we could have come away with even more useful ideas and ways to implement NASA tools."

"I would also like each team to have the use of a computer with Internet access at the hotel. We would have finished with our action plan if we had the ability to work on it at the hotel."

Seeking and Sustaining Coherence

The challenge for the NES program, in terms of design and implementation decisions, appears to be seeking and sustaining coherence in support of program objectives. In this context five major conclusions were identified in response to key evaluation questions. Relevant issues warranting attention are also outlined.

What Have We Learned?

First, it is clear that the NES program selected school teams from urban, suburban, and rural areas with substantial representation of traditionally underserved students. This would allow the program, through regional field centers, to channel resources and supports to targeted schools and teachers as called for in NES Objective 6. Further, demographic indicators of workshop participation showed that NES participants have the appropriate background in terms of preparation, area of instruction, and—most importantly—high and focused motivation to participate in the program.

Second, a review of the top priorities related to science, mathematics, geography, and educational technology indicated a close alignment with the spirit of the two NES academic objectives and NASA's core resources. Collectively, the top academic standards in science, geography, mathematics, and educational technology represent a complementary framework including important science, geography, and mathematics content knowledge. This is further supported by an emphasis on cognitive processes in applied contexts (e.g., problem solving, design approaches) drawing from mathematics and educational technology.

Third, baseline data on perspectives and beliefs about teaching, learning, and technology suggest that NES participants are primed for professional growth through participation in the program. In general, participants can be characterized as somewhat limited in their use of educational technologies and transitional in their perspectives about teaching strategies. Concurrently, participants appear to be motivated to change as suggested by their moderate levels of openness to constructivist ideas and comfort with technology skills and a favorable attitude toward technology.

Fourth, the NES program appears to be well positioned in meeting the criteria of high-quality professional development both in terms of structural and core features. Overall, the NES program can be characterized as a reform type of activity because it involves teacher study groups, teacher collaboration, network development, and a variety of complementary supports. The sustained duration of professional development support, including workshop participation and follow-up contact over a three-year period, should allow for productive experiences. The focus on teacher-teams from the same school (primarily) and grade level should increase the likelihood of productive participation. Further, the content focus of workshops was somewhat high on STEM content, action planning, and general information activities as shown by the combined time spent on these activities (85 percent of the time). The emphasis on curriculum integration and instructional strategies played a secondary role, while career education and family/parental involvement strategies were virtually absent. Under these conditions participants spent most of the time (72 percent of the time) being exposed to a wide variety of noncurricular NASA resources and field center capabilities and facilities, while the rest of the time was spent on using NASA curriculum products and/or on presentations/demonstrations conducted by scientists. Nonetheless, workshop participants spent more than half of the time (58 percent) in professional development activities requiring active learning and involving work on strategic plans.

Finally, the feedback provided by workshop participants on the overall NES program and workshop experiences was highly positive. The program, the content focus, and staffing were all rated high. Open commentary suggested a high level of appreciation for the NES program and a high degree of excitement for the connection to NASA. Specific comments for improvement were voiced regarding issues related to scheduling, duration, and access to computers. Although conflicting in some cases (e.g., scheduling, duration), suggestions for improvement should provide field center staff with valuable feedback for adjusting the design and implementation of summer workshops. More time for team reflection, in particular, appears to be an important issue to consider.

Implications for Seeking and Sustaining Coherence

The implications of these results are clearly connected to seeking and sustaining coherence as design and implementation decisions are made to shape the NES program. In general, the results are both promising and tentative—promising because the program is well positioned in the target school teams and for its potential alignment with high-quality features of professional development, yet tentative because the evidence at this point is not sufficient to make definite claims about the current success of the program. All in all, the structural features of the NES program appear to be sound. The school team concept in the context of long-term commitment, in particular, signals serious NASA support. However, as one participant put it:

> "The school team concept of the Explorer School program is a vast improvement over the one person from each site plan of NEW. However, NASA still expects that people will experience a bonding during the experience that just does not occur. Therefore, we as a team were often made to endure a forced regrouping that took up time when we would rather have been working together. Each school has unique demographics and needs and needs to spend as much time together as possible."

The comment above captures the core challenges for the NES program to seek and sustain coherence over the next couple of years. Although, the NES program may be embracing high-quality features of professional development, it is unclear how actual professional development activities will translate when implemented. Below are some key implications and/or issues to be considered in making design and implementation decisions.

- In seeking and sustaining coherence, it will be important for NES staff to establish connections between content priorities identified by school teams and design/implementation decisions. Based on data available for this report, it was unclear how information on top target standards was used to inform decisions for implementing summer 2003 workshops. Field center staff should examine the alignment between target standards identified by their affiliated teams and workshop goals and determine whether teachers are getting what they need to facilitate work on action plans.

- Further evidence is also needed to clarify the nature and extent of results on core features. As suggested by related results and open commentary, there appears to be room for improvement in terms of balance in content focus, nature of active learning, and allowing for reflection on action plans. Key issues to be addressed by field centers are deciding on the balance in terms of emphasis on content, pedagogy, and action planning; making decisions on the nature and balance of opportunities for active learning; and factoring in sufficient time for teams to engage in meaningful reflection and processing of information during workshops. To this end, we recommend field center staff to review both quantitative and qualitative NEEIS data from their corresponding workshops to identify and gauge the extent of potential adjustments.

- Another issue requiring further attention relates to the use of NASA approved curriculum resources. The use of these curricular resources is central to the definition of the program's intervention. Ultimately, the impact of the program will be tied to both the extent of structural supports (e.g., technical assistance, stipends) and use of NASA's curricular resources. Given the low use of related resources in 2003, it will be important to either increase their coherent use in the workshops and/or improve the identification of such resources in the agendas.

- Attention is also warranted on decisions related to the level of emphasis on family involvement and career education strategies. These two areas are at the core of the NES objectives. However, the emphasis on related strategies was essentially overlooked in summer 2003 workshops. Although these two areas may fall outside the expertise of field center staff, an effort should be made to provide teachers with access to related information. This is perhaps the area in need of most improvement and/or documentation of related design and implementation decisions.

- Concurrently, it will be important for field center staff to examine and document the alignment between strategic plans and follow-up supports. Although initial feedback is positive, it will be important for field center staff to examine and document the alignment of action plans and the nature and extent of sustained (follow-up) support provided after summer workshops. This documentation will be key to sustain the qualification of the NES program as a reform-type activity and to strengthen the program as an educational intervention.

- Regarding the use of evaluation results, it is critical to generate and have access to consistent and accurate data to provide reliable and valid formative assessments of overall program progress. For the evaluation of subsequent workshops, the evaluation team has requested field center staff to provide coded agendas to facilitate the analysis of workshops. In addition, we plan to observe workshops and take notes as a means to verify and support related analyses.

All things considered, designing and implementing activities with multiple high-quality features is a challenging endeavor. Initial results based on summer 2003 workshop data reflect the complexity of related activities in the quest to seek and sustain coherence in the short and long term. Subsequent reports will be instrumental in clarifying the quality and, eventually, the impact of the NES program.

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