NASA Explorer Schools

2003 Cohort

Case Study Reports and Summary Rubric Scores

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NASA Explorer Schools Case Study Profile: A42
2003 Cohort Northwest Florida Public Magnet School—Pre-K-5

Summary Comments Regarding A42
NASA Explorer School (NES) A42 is situated in a northwest Florida suburban area. It received its designation as an elementary magnet school for math, science, and technology studies a year after joining the NES project. In 2003 A42 received a 21st Century Community Learning Center grant to begin a free after-school program, which has helped support the school's NES goal of continuing to be family oriented. This is a Title I school with an 82 percent African-American, non-Hispanic student population. The ethnicity of the student population changed slightly from 2004 to 2005 with a decrease in the overall number of students by 18 percent. The percentages of black students decreased from 80 to 66 percent, and the percentage of white (non-Hispanic) students increased from 19 to 30 percent. (See Table 1 for more details.)

The NES A42 team was formed in 2003 with four members: the school principal, a science teacher, and two fifth grade teachers. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation A42 developed strategic and implementation plans that showed how it would address these academic priorities through the NES project. The NES team and its students have participated in numerous NASA activities, including Microgravity Flight, NASA student symposiums, astronaut visits, Digital Learning Network videoconferencing events, LEGO robotics courses, rocket science activities, family science nights, Lunar Challenge, and Space Station sleepovers. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that A42 has taken advantage of as a NASA Explorer School.

Here are some of the successes that A42 achieved during its three-year period as a NASA Explorer School:

- The faculty developed an aeronautics and aerospace curriculum designed to incorporate NASA and STEM-G lessons and activities for students in pre-kindergarten through fifth grade.
- As a result of the NES partnership, A42 received a $1.7 million grant from Magnet Schools of America to help facilitate its math, science, and technology lab.
- In the 2005-2006 academic year A42 received two awards, one recognizing the achievements of the school's volunteer program, the other providing support for continued student participation in STEM-G competitions and faculty professional development in STEM-G areas.
- While still working toward achieving the district average for math and reading on the Florida Comprehensive Assessment Test (FCAT) in reading

and math, A42 student scores have increased substantially during the three-year NES program. For example, in 2003, 7 percent of A42 fourth-graders scored in the advanced achievement category in mathematics. In 2006 A42 had 23 percent of its fourth-graders scoring in the advanced range on the state math test. (See Outcome 6, Tables 5 and 6, and Figure 1 for more information about student achievement.)

As a school that serves a predominantly poor population, A42 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- Increases in the percentage of students who qualify for either a free or reduced lunch because of low socioeconomic status (the percentage of students qualifying at A42 is 95 percent—the district average is 47 percent). About one-tenth of students have been identified as homeless.
- Reported incidents of violence at the school, affecting overall school climate.
- Lower than average percentage of teachers with advanced degrees—the A42 average is 6 percent lower than the district average.

We examined schoolwide achievements at A42 in terms of the extent to which the school's NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is based primarily on the transcripts of two focus group interviews conducted by telephone with the A42 NES team. The first interview was conducted Jan. 14, 2005, and the second on May 11, 2006. We have also used school web site, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

Outcome 1: Increase participation and professional growth of educators in science.

NES team members feel that they are comfortable sharing and giving information to non-NES teachers. They have given presentations to all science teachers in the district, not just the ones at their feeder schools. They also have worked with about 200-300 teachers in the district. Professional development workshops have also helped NES team members to connect with other NES schools. Future collaborations are being lined up.

The next section examines the extent to which the A42 school implementation of NES addresses the six guidelines for professional growth and development described below.

*Guideline 1: Instructional Strategies**.** Participants are immersed in models of instruction that address these four aspects of science proficiency: (a) know, use, and interpret scientific explanations of the natural world; (b) generate and evaluate scientific evidence*

and explanations; (c) understand the nature and development of scientific knowledge; and (d) participate productively in scientific practices and discourse.

- Teachers report that using NASA materials and resources has helped them change the way they teach classes and has provided them with better tools to do different projects, such as the microgravity experiment.
- The school did not have consistent and scheduled science instruction until becoming a NASA school. It had only fifth grade science. Now every grade has science. The school is planning to align the curriculum from pre-K through fifth grade.

Guideline 2: Time Intensive. The professional development is intensive and sustained

- A42 has encouraged non-NES teachers to adopt NASA activities.
- The NES team members have arranged for AES and field center staff to talk to non-NES teachers and students.

Guideline 3. Active learning. The professional development engages teachers in concrete teaching tasks that are based on the teachers' experiences with students.

- A42 team members report that the help from NASA aerospace education specialists (AES) and its field center is extremely important. NASA people come on board and offer help as the NES team needs and requests their assistance.
- A42 team members stated that the workshops helped them so much with content that they can take back and share with students. The educators don't have to look for things to do or search on the Internet. Everything has been given to them already.

Guideline 4. Content. Professional development focuses on subject matter knowledge and deepens teachers' content skills.

- One of the NES team members, who also teaches music education, said he changed basic music education to the study of sound and sound technology because of his involvement in the NES project. He also applied for a NASA summer job. He said he might change his career in the future.
- Teachers report that the NES program is stimulating teachers' joy for learning science, math, and technology. Their joy and excitement toward these subjects spread to the students.
- They report that they have learned so much content from the workshops that they feel empowered in their teaching.

Guideline 5. Active learning. The professional development is grounded in a common set of standards and must show teachers how to connect their work to specific standards for student performance.

- All of the lessons that teachers are using in some way relate back to space exploration, the history of flight, or astronauts. Throughout the year every teacher is now teaching space education. One first grade teacher presents an Earth Day play. The songs students sing in the play relate to Earth and how Earth fits into space. A42 is the only school in the district doing this.
- The NES team rewrote the entire curriculum for aeronautics and aerospace so that all grade levels are taught aerospace education and exploration, from pre-K through fifth grade.

Guideline 6. Coherence. Reform strategies are connected to other aspects of school improvements.

- As a National Science Teachers Association feature story about NES reported, "As a result of its participation in the [NES] program, this 350-student school was awarded a $1.7 million grant from Magnet Schools of America to help facilitate its math, science, and technology lab. The lab is staffed by a full-time, certified, NASA-trained teacher, who uses an integrated curriculum that features NASA materials and online resources"[1].
- Upon its graduation from the three-year Explorer Schools program, A42 applied for and received an NES Partnership for Sustainability grant from the Florida Coalition for Improving Mathematics and Science Literacy to support student participation in regional and statewide STEM-G competitions.
- Disparities between team lead and administrator in support for the NES project may conflict with some efforts to achieve coherence and sustainability of the program. Comparing interview data with survey reports revealed some conflicts between the team lead and administrator regarding support for the NES project. The team lead reported in the Team Lead Survey feeling extremely satisfied with the effects of the NES project on students' interests and application of STEM-G. However, when asked to rate the administrator's involvement with the program, the team lead reported feeling not at all satisfied. Lack of support by administration is not explicitly mentioned by NES A42 team members during the interview with the team lead, teachers, and administrator, but a previous report (Brief 5) has indicated that disparities between administrator and team members perceptions of the

[1] Retrieved Feb. 20, 2007, from www.nsta.org/main/news/stories/nsta_story.php?news_story.

program has been problematic at some schools which is more frequently reported in surveys than in group interviews—especially those in which the administrator is present.

The two first bullet points above show that the A42 team facilitated schoolwide professional development and sought to sustain its involvement in STEM-G-related enhancements for both teachers and students.

Key findings from the survey data on A42 help us interpret the results of the focus group interviews with other data sources and serve as data triangulation for the case study report. We were able to pair two teachers at A42 and compare them with the rest of NES 2003 cohort teachers. Table 7 illustrates A42's mean and standard deviation on TLC surveys compared with the NES 2003 cohort.

Table 7 shows that teachers at A42 had higher technical skills and attitudes toward technology than other NES 2003 teachers. This finding can be contributed to the results of the school's receiving additional funding other than from NES. As the A42 team lead mentioned in the team lead survey, "We used our NES status to leverage funding from other sources. Individual teachers have written classroom grants, and the school as a whole received $1.7 million to continue our work in math, science, and technology." The increased financial support has allowed A42 teachers to adopt technology in their classroom as well as learn to use some innovative educational technologies. In the team lead survey the A42 team lead rated 5 (as extremely satisfied) on the family involvement, participation of whole school faculty, and NASA staff assistance for integration of NASA materials. This is consistent with our case study findings that more non-NES A42 teachers are participating and want to be part of the team.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
The A42 team purchased the following technologies with NES funding:

- SMART Board™
- Computers
- Projector
- Robotics
- Wireless tablets

Through the NES grant this school now has three new student computers in each classroom and two computer labs with 25 computers in each lab. The school purchased SMART Board™ so that teachers can pop up lesson plans on the interactive SMART Board™. The school also purchased wireless tablets that can

be used at the desk or within cooperative groups. Instead of students coming up front to write on the interactive board, they answer the problem on the wireless tablet from their desks.

The school also ordered the LEGO robotics program for $3,000. Staff from the field center proved invaluable, setting up and programming the robots and showing teachers how to use them.

Outcome 3. Increased family involvement in children's learning.
The school now has two family science nights a year and conducted the Lunar Challenge during September. In fact, the Challenge won the school district's parent involvement program of the year award. Ever since the family science nights began, more and more parents have come to do science activities with their children.

A42 received the Golden School Award from the Florida Department of Education as one of 18 public schools with exemplary school volunteer programs. To receive this award, a school volunteer program must:

- Conduct a staff training program in which a minimum of 80 percent of the school staff have participated during the school year.
- Appoint a school volunteer coordinator to provide leadership for the school volunteer program through recruitment, placement, training, and supervision of participants.
- Have a total number of hours in volunteer service that equal twice the number of students enrolled in the school. These hours will be in the areas that support instruction, mentoring, tutors, advocates, fundraisers, parent organization events, volunteer coaches, and other student functions and activities. (Any function or project that relates to a school function counts. Paid employee time is not to be counted. After-hours work done by teachers is not counted if that activity is a part of their assigned duties.)

Outcome 4. Increased student interest and participation in STEM-G.
Because of NES, students have participated in robotics and Lunar Challenge programs, built rockets, and designed and tested an experiment on a C9 microgravity flight among other activities.

To increase student participation, the NES team has tried to do more hands-on science in the science lab. Each lab has a hands-on activity. Kids enjoy hands-on activities. They bring stuff to school and want to know what it is. They not only like science more, but they participate in science. Their attitudes have definitely changed toward science.

Students report watching the Discovery Channel or Animal Planet. When the Asian tsunami occurred in 2005, they were able to understand what had happened because they had just finished a unit on forces that shape the Earth. Students can head to the computer and play science-related games such as the virtual reality landing on Mars game.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Students who are interested and participate in STEM-G activities have the tendency to:

Participate productively in STEM-G practices and discourse.

> "NASA has brought many attainable activities to the students that they would not normally have participated in until they got to high school" (May 11, 2006).

> "Students will bring stuff to school and want me to tell them what it is" (May 11, 2006).

Show noticeable curiosity in STEM-G-related topics and events.

> "Students are now watching the Discovery Channel or Animal Planet and playing games that are science-related, like the virtual reality landing on Mars game" (Jan. 14, 2005).

Change attitudes about learning.

> "Kids would bring stuff to school and want to know what it is. Their attitudes have changed toward science" (Jan. 14, 2005).

A multiple regression analysis comparing what NASA materials teachers use in the classroom and students' liking that subject shows that there is a correlation between years of exposure to NASA materials in math and science classes and student ratings regarding how much they like these subjects. For example, when teachers used NASA materials in the science class, the survey showed students liking science more. In a similar manner students who like a subject want to pursue it as a career. In this school students indicated liking geology and were considering geologist as one of their favorite job choice.

When asked how often their teachers used NASA materials in the classroom, students responded affirmatively in geography, science, and technology. NES

A42 students scored rated high how much they like geography (Mean 3.38 out of 5) and science (4.00 out of 5).

Actively participate in hands-on and authentic scientific research.

> "Students like hands-on activities" (May 11, 2006).

Outcome 5. Increased student knowledge about careers in STEM-G.
The NES project has brought "attainability" to elementary and middle school students because "they don't have to wait until high school" to participate. Students have learned that there is more to NASA than just space and astronauts. They have discovered a wide range of possible careers connected with the space program.

The following strands indicate students' knowledge about careers in STEM-G. Students who demonstrate knowledge about careers in STEM-G also demonstrate:

Changes in self identify

In the fall 7 percent of students completed the student interest survey, while 19 percent of students did in the spring. A42 school students showed an interest in English, language arts, geology, and science. Students said they liked such jobs as computer specialist, geologist, and engineer.

Increased understanding of and enthusiasm about STEM-G careers.

> "Students were being interviewed by the local newspaper about their experience with the program. And they all said they wanted to be astronauts" (May 11, 2006).

> "We give the name of the scientist who studies those things so if a child really enjoys working with plants and plant growth and germination, then we say the scientist who studies plants is a botanist. So if a child is interested in plants, then maybe he or she should think about becoming a botanist" (Jan. 14, 2005).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.
Since becoming a NASA Explorer and Magnet school, student achievement and enrollment have increased. A42 was recognized in the local newspaper for its reduced gravity program. Students were being interviewed, and all said they

wanted to be astronauts. The state testing scores rose seven points. One respondent said that in 2003 before the NES project, A42 was a "D" school, but has now improved to a "B" school.

The following strands are indicators of increased student ability to apply STEM-G concepts and skills in meaningful ways. Examples from teacher observation are provided after each strand.

Understand and use scientific explanations of the natural world.

> "When the tsunami occurred, they were able to understand what had happened because they had just finished a unit on forces that shape the Earth" (Jan. 14, 2005).

Understand, use, and interpret the nature and development of STEM-G topics.

> "The school was recognized in the local newspaper for its reduced gravity program" (May 11, 2006).

Increase in achievement tests in math and language arts/reading.

> "Student achievement has increased. Our state testing scores rose seven points" (Jan. 14, 2005).

> "In 2003 we were a 'D' school, but since, our school comes up to a 'B' school" (May 11, 2006).

NASA Explorer Schools Case Study Profile: A42
2003 Cohort Northwest Florida—Grades Pre-K-5

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	346	286		
Black, non-Hispanic	276	188		
Asian	1	2		
Hispanic	2	9		
Indian, Alaskan Native	0	0		
White, non-Hispanic	67	87		
School location (rural, suburban, urban, mid-size central city)	suburban	suburban		
School type (public, private, charter, magnet)	public	public		
Title 1 status (yes or no)	yes	yes		
Free and reduced price lunch	89.0%*	95.1%*		

*Statistics, NCFE. (2004). Search for public schools. Retrieved Jan. 18, 2007, from National Statistics, Institute of Education Sciences.

Table 2. Summary of Academic Needs Identified by A42 in 2003

1	Physical Science: Motions and forces
2	Life Science: Populations and ecosystems
3	Life Science: Structure and function in living systems
4	The World in Spatial Terms: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information
5	The World in Spatial Terms: How to use mental maps to organize information about people, places, and environments
6	Physical Systems: The physical processes that shape the patterns of Earth's surface
7	Physical Systems: The characteristics and spatial distribution of ecosystems on Earth's surface
8	Human systems: The patterns and networks of economic interdependence on Earth's surface
9	Physical Science: Transfer of energy
10	Physical Science: Properties and changes of properties in matter

Table 3. NASA Professional Development Opportunities that A42 Teachers Completed

Microgravity Flight Opportunity Workshop
NASA student symposium conference
Orientation workshop
Digital Learning Network videoconferencing
LEGO robotics courses
Aerospace education specialist on-site training

Table 4. NASA Resources and Expertise That A42 Teachers Incorporated into Their Instruction

Microgravity Flight
NASA student symposiums
Astronaut visits
Digital Learning Network videoconferencing events
LEGO robotics courses
Rocket science activities
Family science nights
Lunar Challenge
Space Station sleepovers

Table 5. Summary of A42 School Achievement Reading Test Scores

Grade	Year	Min. Read	Basic Read	Prof. Read	Adv. Read
3	2003	32	32	27	9
4		38	23	32	7
5		57	10	21	12
3	2004	44	14	33	9
4		28	36	24	12
5		49	25	21	6
3	2005	27	12	37	25
4		9	9	65	18
5		24	41	28	6
3	2006	13	18	34	35
4		25	25	31	19
5		24	28	36	12

Table 6. Summary of A42 School Achievement Math Test Scores

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
3	2003	40	28	26	5
4		34	41	18	7
5		63	24	9	4
3	2004	26	33	33	7
4		35	16	29	20
5		43	36	13	8
3	2005	15	25	23	37
4		6	35	38	21
5		39	30	24	6
3	2006	15	18	33	35
4		15	27	35	23
5		16	46	28	10

Table 7. Comparison of NES A42 and 2003 Cohort Teachers

	A42		**2003 Cohort**	
	M	SD	M	SD
Constructivist Teaching Philosophy (CTP)	3.46	0.13	3.29	0.4
Constructivist Teaching Strategies (CTS)	2.67	0.34	2.73	0.6
Constructivist Uses of Technology (CUT)	2.58	0.00	2.73	0.56
Technical Skills (TS)	3.22	0.48	2.99	0.49
Attitudes Toward Technology (ATT)	2.79	0.05	2.17	0.75

NASA Explorer Schools Case Study Profile: A42
2003 Cohort Northwest Florida—Grades Pre-K-5

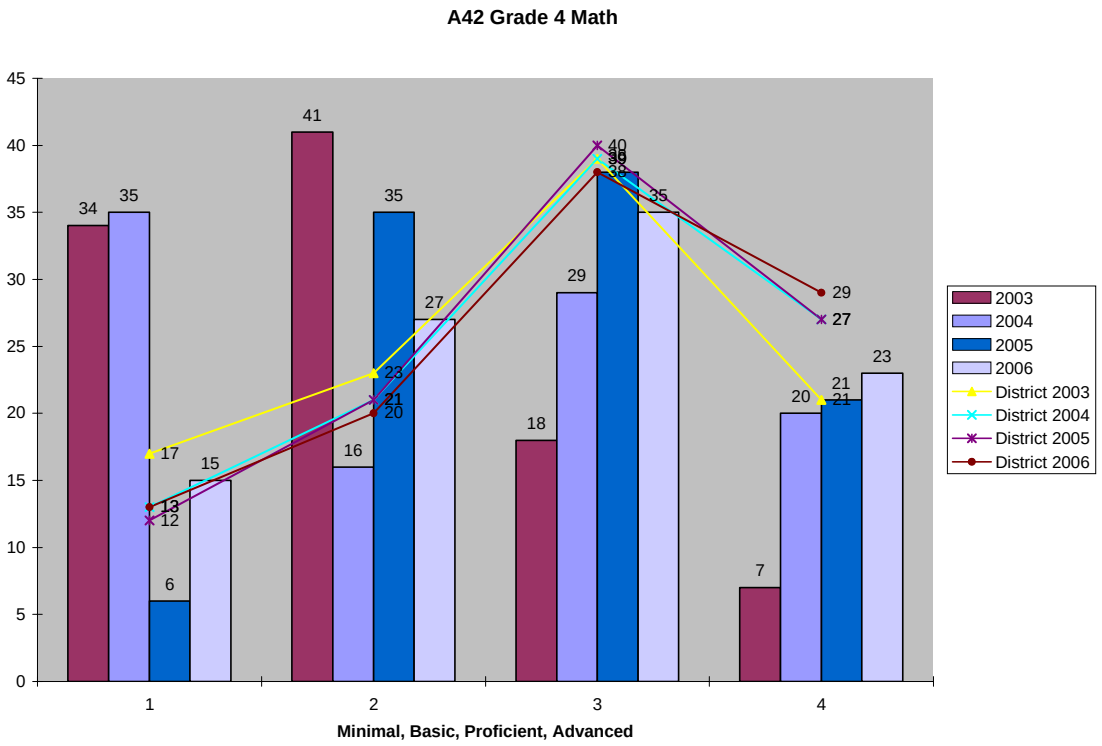

Figure 1. NES A42 fourth grade math scores compared to district averages between 2003 and 2006. Comparing the light blue bar with the maroon bar illustrates the level of improvement in grade four math achievement scores that NES A42 has achieved during its three-year partnership with NASA. While not yet completely equally district averages, A42 shows a trend towards improvement that is evidenced by its cutting in half the percent in the minimum category and by tripling the percent in the advanced achievement category.

NASA Explorer Schools Case Study Profile: B1
2003 Cohort—Urban Fringe of Large City, Oregon Public Grade School: Grades K-8

Summary Comments Regarding NES B1
NES B1 is located in a small, coastal town with a population of about 5,000 in the northwestern region of the United States. When first accepted in the NES program in 2003, B1 had an enrollment of 331. In the 2004-2005 school year enrollment increased to 602 when the school expanded the grade levels it offered from 4-8 to 1-8. The school also increased its teaching staff from 18 to 33 teachers as part of this expansion. About 60 percent of students receive a free or reduced lunch based on their family income status. The attendance rate was below the satisfactory level in 2003-2004, but has met the acceptable level in the last two years. A Federal Correctional Institute is the major employer in this community, and many parents of students either work at or are inmates at the Institute. (See Table 1 for more details about the school demographics.)

We examine school-wide achievements at B1 in terms of the extent to which their NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is primarily based on the transcripts of two focus group interviews conducted by telephone with the B1 NES team. The first interview was conducted on December 27, 2004, and the second interview was conducted on May 5, 2006. We have also used school website, survey data, and national centers for education statistics data to expand upon information provided in the interviews.

Here are some highlights of some of the most outstanding accomplishments achieved by NES B1 over its three-year period as a NASA Explorer School.

- The NES team members feel that they have been in their efforts to include teachers from outside the core team from the beginning of the NES project. The B1 team reports that they work together well, complement each others' strengths, and encourage each other to pursue areas of specialization.
- The B1 NES team has been successful in building a collaborative relationship with their state space grant consortium and has built working relationships with other K-12 and postsecondary science educators through the space grant connection.
- This school team has found ways to keep their local media informed of special events and accomplishments as they have occurred at the school, and the media has cooperated in helping to promote NES activities at the school to the community. The publicity has helped support community and family involvement goals.

The NES B1 team has addressed several challenges they have encountered with the NES. Some challenges are:

- Lack of on-site technical support and instructional technology training to be able to follow through at the school with technology integration that links technology enhancements with NASA curriculum resources.
- Equity in students' learning so that girls and boys are equally engaged and encouraged to pursue STEM-G topics and careers.
- Since the expansion in 2004-2005 involved at least a 40 percent change in population due to boundary or organizational change, B1 did not receive a school rating this year. However, teachers report that they struggle with the pressure of improving students' standardized testing. While B1 student achievement scores have improved, the improvement has erratic and has not been sustained between yearly testing periods. (See Tables 5-8 to see math and reading achievement scores for B1 and district and state comparisons.)
- B1 NES team members describe their challenges in trying to incorporate NASA materials and resources into their school curriculum. The main difficulty they report is that the time required to adapt and integrate NASA materials takes them away from their duties in lesson planning and time to work with students.

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development workshop teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Outcome 1. Increased participation and professional growth of educators in science.

The NES B1 team includes two all subject teachers, a science teacher, and a social studies teacher. Teachers report that the benefits of participating in the NES have exceeded their expectations.

- "When we began we had no clue…we knew that we were going to receive seventeen thousand dollars and we thought we'd have some training, but we didn't have any idea how much training we were going to have or how many wonderful opportunities we were going to be able to participate in…now we realize that, [the seventeen thousand dollars] was just a very small part of the whole program" (May 5, 2006).

The NES project has encouraged teachers to travel and network with other teachers in the district, state, and national level.

- "[I] had never traveled outside the school district before and now have a chance to meet colleagues for other regions of the country. The program has

helped [me] build confidence to interact with new colleagues, gain knowledge about technology, science, and math, [and] increase access to more science, math, and technology resources" (Dec. 27, 2004).

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NES B1 team member describe how being part of the NASA Explorer Schools project has helped them professionally and personally.

- "As teachers, we, our personal growth and our personal knowledge has increased so much that we feel we are becoming much better teachers" (Dec. 27, 2004).
- "[NES] probably helped me the most by just giving me so many new pieces of information and new ideas for teaching science and math particularly and then also for helping me learn more technology" (May 5, 2006).
- "This group has always been inclusive. They have always opened up opportunities for all teachers. Their recognition and support of each others' strengths has helped teachers pursue areas of specialization" (May 5, 2006).

As a result of attending workshops and conferences, teachers report that they have gained more content knowledge and resources that they were able to share with their students. Teachers report that they have presented the project to members of the local Rotary Club, the Kiwanis Club, and the Chamber of Commerce. They describe efforts they have made to collaborate with other regional schools.

- "One of the other parts of our strategic plan is to try to network with other schools and other teachers in our area. And we have spent quite a bit of time working with other schools and providing some in-services, not only for the teachers in our building, but also for teachers in the districts around our area" (Dec 27, 2004).
- "We have worked closely with the Oregon Space Grant Consortium and last September they invited me to their educators at the College level all across the state. In there, we meet teachers all over" (May 5, 2006).

The NES B1 team has been collaborating with local, district schools, government agencies, and building partnerships with regional, state, and national NASA partners. NES B1 team members hope to inspire and support other schools to become part of their NES community. As a result of their efforts, certified professional development opportunities for teachers in the school and county are being offered by the NES B1 team. Tables 3 and 4 provide a list of NASA professional development opportunities and NASA resources used by teachers at B1.

- "…We're so excited because we're going to get [a sister school] now. So we are really looking forward to finding out who the new Oregon school is. We already [have] some summer things planned that we will invite them to and

hopefully they will be able to participate. We will do whatever we can to support them. We did help several teams apply this year, and so perhaps we know some of the people depending on which team has been selected. We do have five schools that are fairly close by, and so it wasn't too difficult to work with them" (May 5, 2006).

NES has elicited much attention from the media and government agencies.

- "We had our congressman visit a couple of weeks ago. When he was talking with the kids, we had the eMission™ from Montserrat and stuff here" (May 5, 2006).
- "We're also the first school that went back and visited our congressional people in regard to this program, as well and visited the NASA Headquarters too" (May 5, 2006).
- "[NES B1] got newspaper coverage on being one of the NASA explorer schools and it published it in our district" (May 5, 2006).
- Media effect. "…our local newspaper is constantly giving us press about what is going [on] with [the] NASA Explorer School…" (May 5, 2006).
- Community involvement. "The local bank donated money to cover costs for decorations and refreshments when NASA administrator came to visit" (May 5, 2006).

Teachers report that the NASA regional office has helped NES B1 with planning the project implementation process, developing an MOU, and filling out required papers for the grant. They report that the assistance they've received from the NASA regional office has been very valuable and that the staff is very supportive.

- "The NASA administrator came. A small school like this, the community noticed" (May 5, 2006).

Teachers at B1 report that integrating NES activities and resources into their school curriculum takes time that pulls them away from some of their other teaching duties. This is an ongoing struggle that team members report they haven't yet found an easy way to resolve. While NES is designed to address individual school needs for STEM-G improvement, the teachers report that this is not always easy to do at the teacher level with their other daily commitments. (Table 2 provides a list of school needs that the B1 NES strategic plan is designed to address.)

- "It has been moderate to difficult to achieve and hard to sustain it. It takes so much time, and that time that we have to take away from our lesson plans and working with students and things like that" (May 5, 2006).

In addition to our analyses from NES case study, we report some key findings from the survey data on NES B1. This data is meant to clarify and substantiate the teacher self-reported information we use for the case study analyses.

For NES B1, we were able to pair four teacher pre/posttest surveys and compare their mean scores with the overall mean of NES 2003 cohort teachers. Table 9 illustrates NES B1's mean and standard deviation on the Teaching, Learning, and Computing surveys compared with NES 2003 cohort.

In the Table 9, NES B1 teachers have more positive attitudes toward technology than other NES teachers in the 2003 cohort. This also has been evidenced from the teachers' interviews that professional development workshops introduce them to different technologies and helped them learn how could use these technologies to enhance their teaching in STEM-G areas. However, NES B1 teachers' mean scores regarding constructivist use of technology in the same Teaching, Learning, and Computing survey was lower than other 2003 NES teachers. This shows us that while teacher attitudes towards technology improved, their scores show that they are not yet able to integrate technology into their instruction in a manner that is consistent with the constructivist model. The focus group interview transcript supports this finding in that B1 teachers described their lack of confidence in using the new technologies and their need for additional on-site technology support.

In the team lead survey, the team lead chose the ratings "extremely satisfied" with team members and "satisfied" with the administrator. Although the administrator had changed every year since B1 started the NES project, B1 team members have made the process as smooth as possible.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.

The NES B1 team purchased the following technologies with NES funding:

- Two laptop computers
- Texas instrument calculators
- LCD projectors
- Robotics
- Videoconferencing equipment

One of the needs identified in Table 2 ("Summary of Academic Needs Identified by B1 in 2003") is getting technology support.

- "We were still very poor with technology [at the start of the NES program] and so that was one of our big goals" (Dec 27, 2004).

- "What makes it a little difficult is the technology. We would like to be able to do more, and it is a little bit frustrating because sometimes you do not have time to get everything set up or you don't have access to something. So that makes it a little bit difficult" (May 5, 2005).

However, as this teacher quote illustrates, the NES B1 school has found ways to utilize the technologies provided by NASA

- "Our technology has come a long way, we still have a huge way to go to catch up to where we would like to be but the technology has improved a lot" (May 5, 2006).

Outcome 3. Increased family involvement in children's learning.

Teachers report that being a NASA Explorer School gave the staff and students at B1 feel a sense of pride because they felt that they were a part of the NASA community. The school and surrounding community responded with enthusiastic support for the NES B1 activities.

- "…We're also working hard on community pride and to have the town and the people in the area be proud of our school and our students and the connection with NASA." (Dec. 27, 2004)
- "Two teachers and lots of the kids were in a community parade…it was wonderful when our NASA float came down the street, to hear the people cheering…grandparents, little kids, everybody just really applauding as the NASA float went through the town…we've been trying to ...stay at this community awareness." (Dec. 27, 2004)
- "...Every June for the first two years we have had a NASA Explorer Schools float in our parade in town, and while we are a small town, many communities turn out for this parade. It's huge, and the people in the crowd stand up and applaud when this Explorer School float goes by and say, 'Thank you.'...I think the kids enjoy it...we have kids sitting on the float, so they're cheering for the kids...they're so excited that we have such a big name in our area…" (May 5, 2006).

Outcome 4. Increased student interest and participation in STEM.

The NES B1 team has observed many positive outcomes of students' interaction with NASA-related activities. Teachers report that being part of the NES program has changed how kids portray themselves, and they are excited to tell others. According to the B1 NES teachers students are:

- learning about science and technology,
- engaging in hands-on activities,
- learning that there is a world of fun things happening beyond the school wall through their use of technology,

- connecting their science learning to real world events, and
- more involved in NES projects than in other classroom activities.

One of the challenges that the B1 team reports is in achieving their goals to encourage and support equity among boys and girls in participation in STEM-G activities and learning opportunities. Here is a B1 teacher view of this challenge.

- "…the importance of both an equal amount of girls and boys involved at every level. And certainly saw a lot of girls really riding the forefront as a result of the strategic goals so we try to key in on those needs as much as possible" (May 5, 2006).

The following strands are indicators of what it means for students to have interest and to participate in STEM activities. Examples from teachers' observations are provided after each strand.

Participate productively in STEM practices and discourse

> "Students are involved in doing PowerPoint presentations and are connecting their science learning to real world events" (Dec. 27, 2004).

Perceive stronger self-concept

> "Oh, I have a story to tell you. I have a new student, she came two days ago to my classroom…when I was introducing her to all the kids, immediately one of them said, 'Does she know that we're a NASA Explorer School?' They were so excited that they wanted her to make sure she knew, and she did know before they told her that...the kids are very proud..." (May 5, 2006).

Change attitudes about learning

> "Students are very enthusiastic about the project. They are motivated to learn about science and technology. They are more involved in this project than in other classroom activities" (Dec. 27, 2004).

Actively participating in hands-on and authentic scientific research

> "Students are engaged in hands-on activity, and learn that there is a world of fun things happening beyond the school wall through their use of technology" (Dec. 27, 2004).

Outcome 5. Increased student knowledge about careers in STEM.

No evidence was shown from B1 teachers' interviews regarding increased student knowledge about careers in STEM.

Outcome 6. Increased student ability to apply STEM concepts and skills in meaningful ways.

A multiple regression analysis of student responses on the student interest assessment was conducted. B1 students had mean scores at least one standard deviation above the overall item mean scores in "How often do you or your teachers use NASA materials in…"Geography and Science. B1 students have experienced their teachers' use of NASA materials in both geography and science subjects.

The NES evaluation team has observed a steady climb in students' math and reading test scores as evidenced in Tables 5-8.

Table 1. School Demographics

	2003-2004	2004-2005	2005-2006
All students	331	602	588
Black, non-Hispanic	5	7	
Asian	1	3	
Hispanic	27	56	
American Indian, Alaskan Native	25	58	
White, non- Hispanic	273	476	
School Location (rural, suburban, urban)	urban fringe of large city	urban fringe of large city	urban fringe of large city
School Type (public, private, charter, magnet)	public	public	public
Title 1 status (yes or no)	no*	yes*	
English Language Learners	4.8%**	5.6%**	5.7%**
Free and Reduced Price Lunch	60.73%*	57.31%**	
All teachers	19**	34**	36**

*N.C.E.S. (2004, 2005). Search for public schools. Retrieved January 29, 2007
** Retrieved January 29, 2007, ReB1 school report card. (2004, 2005, 2006).

Table 2. Summary of Academic Needs Identified by B1 in 2003

1	Design: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
2	Use content-specific tools, software, and simulations to support learning and research.
3	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.
4	Data Analysis and Probability: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
5	Communication: Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
6	Representation: Select, apply, and translate among mathematical representations to solve problems
7	Physical Science: Transfer of Energy
8	Life Science: Diversity and adaptations of organisms
9	Earth and Space Science: Structure of the Earth system
10	Environment and society: How human actions modify the physical environment.

Table 3. NASA Professional Development Opportunities that B1 Teachers Completed

Orientation workshop
Signals of Spring
History of Winter
NASA convention in Richmond, VA

Table 4. NASA (and NASA-affiliated) Resources Used

e-Missions
Rockets
Microgravity

Table 5. NES B1 Math Achievement Scores*

Grade	Year	Not Met	Met	Exceeded
5, 8	2003	54.8	34.7	10.5
5, 8	2004	65.7	29.3	5.1
3, 5, 8	2005	43.9	39.6	16.6
3, 5, 8	2006	37.9	51.7	10.4

Table 6. Comparison of the percentage of students meeting or exceeding the state standards in Mathematics Knowledge and Skills*

Grade	Year	Not Met	Met	Exceeded
5, 8	2003	54.8	34.7	10.5
5, 8	2004	65.7	29.3	5.1
3, 5, 8	2005	43.9	39.6	16.6
3, 5, 8	2006	37.9	51.7	10.4

Table 7. Reading, English/Language Arts Achievement Scores*

Grade	Year	Not Met	Met	Exceeded
5, 8	2003	42.7	46.8	10.5
5, 8	2004	59.5	35.5	5.0
3, 5, 8	2005	57.8	30.6	11.6
3, 5, 8	2006	49.5	43.0	7.5

Table 8. Comparison of the percentage of students meeting or exceeding the state standards in Reading Knowledge and Skills*

Grade	Year	B1	District	State
5, 8	2003	65.0	69.0	72.0
5, 8	2004	55.0	56.0	70.0
3, 5, 8	2005	61.0	64.0	79.0
3, 5, 8	2006	63.0	67.0	81.0

*Source: Oregon Statewide Assessments, Chapman 2002-2003 and 2003-2004 School Report Cards; and Faulconer-Chapman2004-2005 and 2005-2006 School

Table 9. Comparison of NES B1 and 2003 Cohort Teachers on TLC Survey

	B1		**2003 Cohort**	
	M	*SD*	*M*	*SD*
Constructivist Teaching Philosophy (CTP)	3.15	0.28	3.29	0.4
Constructivist Teaching Strategies (CTS)	2.62	0.25	2.73	0.6
Constructivist Uses of Technology (CUT)	1.93	0.42	2.73	0.56
Technical Skills (TS)	2.43	0.77	2.99	0.49
Attitudes Toward Technology (ATT)	3.00	0.40	2.17	0.75

NASA Explorer Schools Case Study Profile: C6
2003 Cohort—Inner City, Minnesota Public Elementary School: Grades K-6

Summary Comments Regarding NES C6
NES C6 is an inner city, public elementary science magnet school in Minnesota. This school was selected as a NASA Explorer School in 2003 when it was in the fourth year of a district reform effort to develop a research-based program around inquiry-based science instruction. Its enrollment dropped from 364 in the 2003-2004 school year to 298 during 2004-2005. About 55 percent of students receive free/reduced lunch, and 31 percent of students speak English as a second language. There are more than 70 languages and dialects spoken within the city. (See Table 1 for more details.)

We examine schoolwide achievements at C6 in terms of the extent to which its NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is based primarily on the transcripts of two focus group interviews conducted by telephone with the C6 NES team. The first interview was conducted on Feb. 1, 2005; the second, April 24, 2006. We have also used school web site, survey data, and Department of Education school data to expand upon information provided in the interviews.

Here are some of the accomplishments achieved by NES C6 over its three years as a NASA Explorer School:

- Since becoming an NES school, teachers have trained to become familiar with science content and different technology tools to promote students' learning. Teachers and students are now engaged more deeply in science because of their direct access to NASA scientists made available through NES field center support.
- More resources and materials to support scientific inquiry are now available to all K-6 students. Also, C6 has been encouraging students to do more nonfiction science reading to promote students' interest and participation in STEM-G.
- Teachers have worked with each other using NASA materials to develop coherent STEM-G instruction and effective strategies for all the students.
- The educators at C6 have sought out opportunities to collaborate with a local university. As a result of these outreach activities, they received a grant from the University of Arizona.
- The state annually tests all third- and fifth-graders in reading and mathematics. The number of students scoring below grade level dropped over the last three years from 78 percent to 39 percent. Teachers report that their involvement in the NES project is a contributing factor in student improvements in achievement tests. (See Tables 5 and 6 for more information about student achievement.)

C6 has addressed several challenges it has encountered with NES:

- Lack of time combined with the vast amount of information available for teachers is C6's biggest challenge. NASA offers so many educational resources for teachers, and while this should be a benefit, sifting through all this material takes time. C6 teachers reported spending a large amount of time preparing a lessons using NASA materials.
- Most NASA resources are for the fifth and sixth grades, teachers said, which led to problems identifying appropriate materials for third and fourth grades.
- Team members said lack of ongoing support and use of materials was a challenge. The implementation plan outlines the school goals, but they have found these goals to be unrealistic. The teachers would like to receive constructive and timely feedback on the goals they set as their school outcomes for participation in NES.
- Teachers said there are personality conflicts among team members. Although there are ongoing conversations between teachers, it has been difficult to work with one another.

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Outcome 1. Increased participation and professional growth of educators in science.

Three of the original NES C6 team members are still engaged, active NES team members. The team includes a curriculum supervisor, who is the team lead and administrative representative; a fifth and sixth grade teacher; a third and fourth grade teacher; and a third grade teacher, all of whom teach all subjects. An additional elementary classroom teacher is also part of team. The team communicates 2-3 times a year as reported by the team lead in the team lead survey. See Table 2 for the academic needs identified by C6 in 2003.

The C6 team attended the NES orientation at field center C. Team members reported that because of NES, they are exposed to many great resources and actually take on the challenges in some programs, for example, the robotics. They said the NES professional development workshops have provided them access to STEM-G-related curriculum and technology. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that C6 has taken advantage of as a NASA Explorer School.

The following are examples of professional growth, challenges faced, and achievements made at C6 in terms of the professional growth guidelines presented in Brief 5 (Ruberg & Martin, 2007).

Guideline 1- Instructional Strategies.

During its partnership with NASA, C6 has participated in a number of NASA professional development opportunities that teachers report allowed them to "connect with some of the real science that has happened" (Feb. 1, 2004). Complete listings of workshops attended and NASA activities used by C6 can be found in Tables 3 and 4. Here are some science experiences the C6 team engaged in:

- Participation in a Reduced Gravity Flight Opportunity in which they conducted an experiment and experienced microgravity in context of professional development training provided at NASA field center F. Teachers created a video of this experience to share with their students.
- A videoconference with the International Space Station crew in which students were able to directly interact with NASA astronauts in space.
- Attendance at a scientific study of winter conference that included Earth science inquiry activities.
- Participation in e-Mission™ Operation Montserrat in which students are engaged in problem-based learning science activities within a simulation context.

The C6 team described how the NES professional development has given teachers a better understanding of science as practiced by NASA scientists.

> "I think one of the things that it has provided [is] a window into how NASA scientists are out there working and what is the work of the scientists who are there. So it was interesting to, and in some regards, stepping out as an educator and stepping into the world of science that's there" (Feb. 1, 2004).

In addition to our analyses from case study, we report some key findings from the survey data on C6. These data help us compile a more accurate case study analyses and provide a means for us to triangulate the data collected for the C6 case study report.

- When asked how often students take part in doing hands-on/laboratory activities, all four teachers responded "1-3 times per week" in the Teaching, Learning, and Computing (TLC) survey.

- When asked about how often do students in this class take part in working in small groups to come up with a joint solutions or approach to a problem or task, one teachers responded "1-3 times per month, two teachers responded "1-3 times per week", and one teacher responded "almost everyday" in the TLC survey.
- In TLC survey, here are some of the answers to how often C6 teachers accomplish the following goals:
    - Elicit students' ideas and opinions: 3 out of 4 teachers responded "always".
    - Get students to justify and explain their reasoning: 3 out of 4 teachers responded "very often".
    - Have students relate what they are working on to their own experience: 2 out of 3 teachers responded "very often".
- When asked about as the result of being a NASA Explorer School, how much do you anticipate you will incorporate inquiry activity in the instruction in the teacher involvement survey, two NES C6 team responded either "some" or "quite a bit".

Guideline 2 - Time Intensive.

Having previously participated in a federal project that focused on use of scientific inquiry, C6 appears to seek out collaborations that will support and sustain its faculty's involvement in learning about and applying scientific inquiry teaching strategies. The NES project is designed to apply the resources of NASA to help teachers engage their students in authentic scientific inquiry activities. It should help C6 keep its faculty involved in inquiry teaching practices. The listings of professional development workshops attended and resources used show that C6 took advantage of the opportunities for professional growth provided by NES.

In 2005 teachers indicated that their access to and support from NASA field center staff was beneficial.

> "Teachers spent a week in the field center during the summer. People from the field center would come up to visit the school and do some work here with us, usually three to four times a year. They usually brought materials that we haven't had access to. For example, they brought telescopes to our astronomy night and family night" (Feb. 1, 2005).

> "I talk to [field center staff] quite a bit…and they're very helpful. They e-mail back, or they call back. If there's anything that they can e-mail us or send us or people that they can contact that we can't, they can get hold of

> those people right away. They're so fast when we ask for anything. And they do have things that they e-mail us and things that they have or videotapes that they'll send me. Even scientists that they help us get in contact with" (Feb. 1, 2004).

In 2006 teachers explained that the help from the field center and aerospace education specialist was limited because of staff changes at NASA field center C.

> "School doesn't have a lot of NASA field center people coming around. We had some first year, but not after that. We had contact with a field person from Minneapolis for a short time" (April 24, 2006).

> "[We have] not been taking a lot of advantages [from AESP] because Minnesota is in transition. We don't have one assigned to yet" (April 24, 2006).

In the team lead survey the team lead rated "satisfied" on the participation of whole school faculty and "not satisfied" with the NASA staff assistance for integrating NASA materials or for using inquiry. Although the team lead reports teachers using technology tools provided by NES and inquiry instructional strategies taught during the professional development workshop, the team lead still has reservations about the impact of the NES project because of the lack of in-house facilitation and delays in responding to requests for help.

Guideline 3 – Classroom Practices.

The excerpt below shows how the professional development opportunities for teachers stimulated their interest in researching how they could integrate these activities into their content teaching.

> "When we started doing this research for the downlink and especially when we did it for the spinning tops and the KC135, we talked about a lot of stuff, and our science time was devoted to those activities. With the downlink, a lot of our science time was devoted to the activities to research that, and then we also spent math time trying to figure out how much is a million, and how they measure in millionths. We did a lot of math during that time" (Feb. 2, 2004).

The team leader reported teachers using technology tools provided by NES and inquiry instructional strategies taught during the professional development activities (spring 2006).

> "I love science, and I love the space component of it, and sharing it with my students, and just getting the kids excited…But I like … that I've been able to get [the students] involved and the parents involved, community members involved, and that NASA scientists are talking to my class and e-mailing them back and forth. It's been a great thing for the kids. It's really been fun" (Feb. 1, 2004).

> "I think it's created a … regard for science [and helped students] to make a greater connection to real world applications. It's generated increased motivation" (Feb. 1, 2004).

In addition to our observations from teacher focus group interviews, we also sought out key findings from the Teacher Needs and Involvement survey on how much do NES C6 teachers anticipate the following the instruction:

- Align NASA STEM-G resources to national, state, or district standards: One teacher responded "quite a bit", and two teachers responded "some".
- Integrate more space science into my instruction: One teacher responded "a lot", one teacher responded "quite a bit", and one teacher responded "some".
- Integrate more technology into my instruction: Two teachers responded "quite a bit", and one teacher responded "some".
- Integrate more geography into my instruction: One teacher responded "quite a bit", and one teacher responded "some".
- Incorporate more technology into my instruction: Two teachers responded "quite a bit", and one teacher responded "some".
- Integrate more engineering into my instruction: Two teachers responded "some", and one teacher responded "a little".
- Incorporate more STEM-G career information into my instruction: All three teachers responded "some".

Guideline 4 – Content Knowledge.

Below are excerpts from the interviews with C6 teachers that show how teachers were able to link special NES opportunities such as the ISS downlink with their content teaching.

> "There was a lot of information that we just had to sit down at the computer and read or get a book and read, find a web site somewhere and print it off and have groups read it. So we've really used [what we've learned from the professional development opportunities]" (Feb. 2, 2004).

> Teachers at C6 integrated NES science across the curriculum. They described how they incorporated things into science, math, reading, and writing by getting students engaged in "writing things that they've noticed, things that they've observed, things that they've learned and then applying it to things that they can find later on" (Feb. 2, 2004).
>
> "A science unit example: We do a fifth grade unit on the Earth changing over time—studying land forms—and have done things like bridge into that with an exploration of the surface of Mars with tagging that into some radio telemetry following Monarch's flight and building some of those kinds of connections. There are changes over time that have tapped into other resources through NASA" (Feb. 2, 2004)

In addition to our observations from teacher focus group interviews, we also sought out key findings from the Teacher Needs and Involvement survey on how comfortable are the teachers right now teaching concepts in each of the following areas:

- Science: All three teachers who filled out the survey responded "quite a bit" comfortable in teaching science concepts right now.
- Educational technology: Two out of three teachers responded "quite a bit" comfortable in teaching educational technology concepts right now.
- Engineering/technology education/robotics: Only one teacher responded "quite a bit" comfortable in teaching engineering concepts while two other teachers responded "not at all" and "a little".
- Mathematics: All three teachers responded feel "quite a bit" and "a lot" comfortable in teaching mathematics concepts right now.
- Geography: All three teachers responded feel "quite a bit" and "some" comfortable in teaching engineering concepts right now.

Guideline 5 - Active learning.

Table 2 lists the standards selected by teachers at C6. Based on the focus group interview transcripts, we can see how C6 teachers have used their professional development experiences and access to NASA resources to address the following specific national standards from their list of needs.

- National Educational Technology Standards: Grades 6-8: Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
- National Educational Technology Standards: Grades 6-8: 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.

- Earth and Space Science: Earth in the solar system.
- Number and Operations: Understand numbers, ways of representing numbers, relationships among numbers, and number systems.
- Problem Solving: Monitor and reflect on the process of mathematical problem solving.
- National Geography Standards: Human systems: The characteristics, distribution, and migration of human populations on Earth's surface.

A quote from one of the focus group interviews further illustrates how the C6 teachers integrated their NES experiences into their instruction:

> "We've purchased digital cameras for use in the classrooms so they can take pictures of the work that the kids are doing, [and] kids can take more pictures of work in the field and come back and take a look at it. We purchased a large format printer, which allows us to print out some of the posters of some of the NASA materials" (Feb. 1, 2004).

Guideline 6 - Coherence.

Being an NES school has encouraged C6 to seek out partnerships with non-NES schools. C6 has been working with a local high school and receiving a Space Grant from the University of Arizona as a result of collaborating with a local university.

Participating in the NASA Explorer School project extends C6's experience as a school site for another national initiative to encourage teachers to incorporate inquiry-based teaching practices. Here are excerpts from a web site describing C6's previous involvement with inquiry strategies for teaching science.

> The C6 K-6 school opened in the fall of 1999 as a magnet school designed around the instructional focus of inquiry. The school features an Inquiry Zone (based upon elements of Joseph Renzulli's schoolwide enrichment model) where students work with teachers, volunteers, student teachers, and interns to engage in extended learning experiences outside the classroom. The Inquiry Zone is designed to extend students' scientific inquiry experiences and provide students the opportunities to pursue personal interests while being taught skills for research and exploration.

The evaluation team sought to use some survey questions from C6 Team Lead survey and found the following key findings. The team lead expressed their NES team is "very satisfied" with the communication with NASA staff, effect of the program on student application of STEM-G and student interest in STEM-G,

NASA staff assistance in planning for sustainability, development of community partnerships, alignment of NES with the school's plan, team teachers use of inquiry and technology, involvement of administrator team member, and school sustainability plan. The C6 team lead expressed "not at all to somewhat satisfied" with NASA staff assistance for integration of NASA materials, NASA staff assistance for using inquiry, family involvement, participation of the whole school faculty, and use of videoconferencing.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
C6 purchased the following technologies with NES funding:

- Videoconferencing equipment
- Computer equipment
- Digital camera
- Large format printers (to print student digital images)
- Robotics

Through the NES project C6 purchased different technology tools for teachers and their students.

> "Teachers want to use the science notebook. That is something that teachers learned from the professional development workshop" (April, 24, 2006).

In order for students to work on programming, C6 purchased robotics parts.

> "Our team is working on getting robotics into the school and getting a robotics program up and running and ready for older grades to use. And the school has bought parts for kids to build and program" (Feb. 1, 2005).

In addition to our analyses from the NES case study, we were able to pair two teachers at C6 and compare them with the rest of NES 2003 cohort teachers. Table 7 illustrates C6's mean and standard deviation on TLC surveys compared with the NES 2003 cohort.

Table 7 shows that C6 teachers have lower perceptions of constructivist uses of technology and technical skills than other NES teachers while they reported more positive attitudes toward technology. This finding further supports our case study results that indicate that even if teachers demonstrate positive attitudes toward technology, they are not yet equipped with sufficient knowledge about integrating technology to deliver the instruction effectively.

Ongoing support or instruction on the integration of technology should be provided to the teachers.

Outcome 3. Increased family involvement in children's learning.
The C6 team initiated several NASA-related events, such as family science night and astronomy night. These events are to increase parents' awareness of school events and their kids' learning.

> "C6 has a parent information fair at the district. A number of prospective parents stop by and ask about this NASA stuff and what it's about. There were a number of parents who asked about it, talked about it, and noticed it" (Feb. 1, 2005).

Searching for postings about C6 outreach and family events on the Internet, we found the following comment from a C6 parent.

> "I have a son with a learning disability, and I can't express my thanks enough to the special education staff along with his regular teachers. They have made sure my son was tested thoroughly in order to enable a correct assessment of his disabilities. They made sure that we were understanding and aware of absolutely everything involving the testing and evaluation process. I am totally confident and very much grateful with the entire staff of C6, so a big thank you to them. And [NAME] is about the best principal ever. We are very lucky to have her."

Outcome 4. Increased student interest and participation in STEM-G.
Teachers observed students' interest and participation increase through the use of NASA materials. NASA materials emphasize relating concepts to real life. Such everyday materials also enhance the situational interest because they add meaning, and the activities are more relevant to real life because they use real life materials. The following example is the teacher's observation of students' interest and participation in STEM-G.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Students who are interested and participate in STEM-G activities have the tendency to:

Participate productively in STEM-G practices and discourse.

> "Students' motivation is increased because they can make a greater connection to real world applications. Kids are excited about it. They seem to care more" (Feb. 1, 2005).

Actively participate in hands-on and authentic scientific research.

> "A lot of science times are devoted to the research activities, and we spent math time to figure out how much is a million and how they measure in millionths. During the reading time they sit down at the computer, find the web site, and print it off. Groups read it" (Feb. 1, 2005).

Outcome 5. Increased student knowledge about careers in STEM-G.
Students' perceptions or internalized meanings of self and others in STEM-G may shape or limit their interests in STEM-G. As described from the self-identity theory, when students are given various choices to make, they are more likely to view themselves differently (Burke & Reitzes, 1981). The NES project opens students to unlimited choices and resources that will lead them to acquire a specific scientific identity.

The following strands indicate students' knowledge about careers in STEM-G. Students who demonstrate knowledge about careers in STEM-G demonstrate:

Increased understanding of and enthusiasm about STEM-G careers.

> "The teachers are introducing kids to different programs, such as the Mercury, Gemini, and Apollo programs. Kids realize there are other things that NASA does; it's not all astronauts. They also are involved in studying satellites, in the sun and Earth, and star programs" (Feb 1, 2004).

Changes in self-identity.

> "Kids are much more aware of space science now. They think of themselves as scientists. They have a bumper sticker, 'There is a place for you at NASA.' Maybe not everyone will be astronauts, but they can be something at NASA" (April 24, 2006).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.
No specific examples on student ability to apply STEM-G concepts and skills in meaningful ways were found in the focus group teacher interview. However, in the student interest survey, students rated themselves good at presenting the results of an investigation or project to the class.

NASA Explorer Schools Case Study Profile: C6
2003 Cohort—Inner City, Minnesota Public Elementary School: Grades K-6

The following strands are indicators of increased student ability to apply STEM-G concepts and skills in meaningful ways. Examples from teacher observation are provided after each strand.

Increase in achievement tests in math and language arts/reading.

> "There are a number of variables that could impact students' test scores. It would be difficult to connect a strong causal relationship to just the NASA people. But it plays into it with increased scores" (Feb. 1, 2005).

As one of the case study schools, C6 was asked to take the student interest survey in spring 2006. A total of 79 students completed the questionnaire. C6 students had mean scores at least one standard deviation above the overall item mean scores in the following items:

- "Tell us how much you like…" English, language arts.
- "Rate how good you are at…" presenting the results of an investigation or project to the class.
- "How much would you like to have these jobs?" Computer specialist, engineer.
- "How often do you or your teachers use NASA materials in…" geography?

Clustering the questions indicated that students like English and language arts subjects. C6 students felt confident presenting the results of an investigation or project to the class and would like to have jobs as computer specialists and engineers. In cases where teachers used NASA materials in their geography class, students also indicated a higher self-efficacy in presenting the results of an investigation.

In the case of C6, the use of NASA activities is associated with students' showing a higher level of confidence in how good they are at presenting the results of an investigation or project to the class. In these areas the C6 student responses were well above the average school ratings.

NASA Explorer Schools Case Study Profile: C6

2003 Cohort—Inner City, Minnesota Public Elementary School: Grades K-6

Table 1. School Demographics

	2003-2004*	2004-2005**	2005-2006
All students	364	298	
Black, non-Hispanic	106	98	
Asian, Pacific Islander	80	59	
Hispanic	40	37	
American Indian, Alaska Native, Native	7	5	
White, non-Hispanic	131	99	
School location (rural, suburban, urban, large central city)	Inner City	Large central city	
School type (public, private, charter, magnet)	Public	Public	
Title I status (yes or no)	Yes	Yes	
English language learners	31%		
Free and reduced lunch	55%	53%	
Teacher population		24	

*Statistics for 2003-2004: NES Team Application

**Statistics for 2004-2005: National Center for Education Statistics (NCES). Retrieved March 6, 2007, from Institute of Education Sciences web site.

Table 2. Summary of Academic Needs Identified by C6 in 2003

1	National Educational Technology Standards: Grades 6-8: Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems
2	National Educational Technology Standards: Grades 6-8: 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
*	Earth and Space Science: Earth in the solar system
*	Number and Operations: Understand numbers, ways of representing numbers, relationships among numbers, and number systems
*	Geometry: Use visualization, spatial reasoning, and geometric modeling to solve problems
*	Data Analysis and Probability: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
*	Problem Solving: Monitor and reflect on the process of mathematical problem solving
8	Physical Science: Motions and Forces
*	National Geography Standards: Human Systems: The characteristics, distribution, and migration of human populations on Earth's surface
*	Representation: Select, apply, and translate among mathematical representations to solve problems

*These academic standards were selected as needs, but were not selected with a number value.

Table 3. Professional Development Opportunities C6 Teachers Completed

NES orientation workshop
NES content workshop (astrobiology)
NES sustainability conference
National conferences
History of Winter workshop, Lake Placid, NY
GLOBE workshop
NSTA convention, Atlanta
Facilitated professional development workshops for colleagues at C6
NES student symposium
Live demonstrations
Robotics
Reduced Gravity Opportunity workshop at Johnson Space Center

Table 4. NASA Resources and Expertise That C6 Teachers Incorporated into Their Instruction

International Space Station downlink
Magic Math
NASA web site
Simulated environment
Planets
Reduced gravity flight experiment
Space station sleepovers
Lunar Challenge
LEGO robotics
Field center staff visits (on and off site)
Robotics
Mercury, Gemini, and Apollo programs
Sun, Earth, and star satellite programs
Operation Montserrat
Desert Rats
Digital Learning Network videoconference programming, such as microgravity and connecting with science fiction writers

Table 5. Summary of C6 School Achievement Reading Test Scores

Grade	Year	Min. Reading	Basic Reading	Prof. Reading	Adv. Reading
3	2003	39.1	21.7	32.6	6.5
5		34.5	20.7	34.5	10.3
3	2005	21.57	25.49	39.22	13.73
5		18.61	4.65	48.84	27.91

Table 6. Summary of C6 School Achievement Math Test Scores

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
3	2003	34.1	23.4	36.2	6.4
5		65.5	10.3	20.7	3.4
3	2005	30.77	7.69	46.15	15.49
5		13.96	13.95	55.81	16.28

Table 7. Comparison of C6 and 2003 Cohort Teachers on TLC survey

	C6		2003 Cohort	
	M	SD	M	SD
Constructivist Teaching Philosophy (CTP)	3.54	0.19	3.29	0.4
Constructivist Teaching Strategies (CTS)	2.67	0.35	2.73	0.6
Constructivist Uses of Technology (CUT)	1.84	0.04	2.73	0.56
Technical Skills (TS)	2.79	0.30	2.99	0.49
Attitudes Toward Technology (ATT)	2.59	0.71	2.17	0.75

NASA Explorer Schools Case Study Profile: D106
2003 Cohort—Mid-size City, California Public Elementary School: Grades K-5

Summary Comments Regarding NES D106
NES D106 is an elementary school located in Northern California. This school was selected as a NASA Explorer School in 2003. Its enrollment was 775 students during 2003-2004; that decreased to 734 in the 2004-2005 school year. In 2003-2004 about 76 percent of students were eligible to receive a free or reduced lunch based on their family income status. In 2004-2005 the percentage of students eligible for Title I assistance increased to 82 percent. In 2004-2005, 57 percent of students qualified as English language learners, which is higher than the district average. Special education students make up 6 percent of the school population. (See Table 1 for more information on the school demographics.)

We examine schoolwide achievements at D106 in terms of the extent to which its NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is based primarily on the transcripts of two focus group interviews conducted by telephone with the D106 NASA Explorer School team. The first interview was conducted Feb. 1, 2005; the second, April 26, 2006. We have also used the school web site, survey data, and Department of Education school data to expand upon information provided in the interviews.

Here are some of the most outstanding accomplishments achieved by D106 over its three years as a NASA Explorer School.

- Before 2003 D106 did not have a science program. Students experienced science activities and materials through the D106 school partnership with NASA. (See Table 2 for the summary of academic needs that are STEM-G-related identified by D106).
- The educators at D106 have sought out opportunities offered at the local university and continue to build scholarly activities with them.

The NES D106 team has addressed several challenges it encountered with NES:

- Teachers report that having a lack of common time to plan for the next event or next series of events hinders their ability to collaborate on implementing new activities, reviewing what has been done, and planning future STEM-G-related activities.
- Infrastructure challenges within the school community have led to changes in the school NES team membership, and as a result, the weekly NASA science rotation eventually was discontinued.
- Teachers explained that before their participation in the NES project; they did not have a science program. Now because of the low student performance on reading tests, teachers get sanctioned if their students do not show improvement in language arts. They describe how hard it is to convince

people to take meaningful time for science because the other teachers believe they are going to be in trouble if student language arts scores do not improve.

- The late arrival of the NES funding both from NASA and from the district caused some problems in the school's ability to implement its NES plans. The first-year funding was a year late, and the second-year funding was half a year late.
- Another challenge teachers reported was that the students in fifth grade hadn't been exposed to science or work at the level expected in fifth grade. As a result, teachers had to go back and teach some skills before they could do activities requiring higher level skills.
- It is hard to evaluate the impact of the program on students' parents because English is not the first language for most of the parents. D106 teachers found that their evaluation was limited to tracking attendance at events like the star parties that have been initiated at the school as part of the NES project.
- Lack of on-site technical support personnel has been a problem for technology integration. For example, the videoconferencing equipment was broken and had not yet been repaired, resulting in the school's not participating in NASA Digital Learning Network (DLN) events.

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development workshops teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Outcome 1: Increased participation and professional growth of educators in science.

The NES D106 team consists of three teachers and an administrator. The team lead is a fifth grade teacher as well as school technology coordinator. The other two teachers are also fifth grade teachers. The team communicates informally weekly, mostly through e-mail.

NES D106 sent teacher representatives to workshops and conferences. For the workshops teachers went to NASA's Jet Propulsion Lab and Goddard Space Flight Center. In attending conferences, teachers have gone to the National Science Teachers Association (NSTA) conference in Albuquerque, NM, and the FTTM conference in Salt Lake City, UT. At NSTA teachers learned about robotics and computer technology that can be integrated into robotics. At FTTM teachers learned different teaching methodologies for mathematical concepts. In 2006 the NES D106 team attended the NES sustainability conference in Huntsville, AL.

In addition to participating in NASA-sponsored workshops and conferences, the NES D106 team also attended some training at the local university and has continued to collaborate with it. Regarding outreach, the NES D106 team has offered the NES 2005 cohort help with whatever members need. (See Table 3 for professional development opportunities that D106 teachers completed.) The outreach for other non-NES teachers has been a struggle:

"We have been trying to branch out to other teachers. We want to pick people who can operate at some level of self-sufficiency and can function within a team without disrupting the team. So only people who are self-motivated and willing to get in line with what was already going on want to join the team—and not necessarily people who are looking for a huge amount of accommodation or adjustment to meet their particular needs" (April 26, 2006).

The D106 team highly values its participation on the NES project overall. NES has allowed a lot of freedom with the materials that the team has been able to purchase. School teachers are getting different perspectives and gaining a more national view. Attending different conferences also helps teachers to build up their resumes. NES has certainly changed how teachers do things professionally as well as some of their professional values.

D106 failed to complete the following required surveys in 2006: Teaching, Learning, and Computing; Team Lead, and Administrator surveys. Therefore, we did not have numerical data to triangulate the qualitative case study findings. Having incomplete NES evaluation instruments limits the researchers' abilities to draw conclusions regarding the relationship between the NES project and teachers' professional growth.

In the 2005 Administrator Survey, the D106 administrator's responses reflected positive attitudes toward technology applications to support student learning. However, in the concerns and issues section of the survey that addressed the implementation of the NASA Explorer Schools partnership at D106, the D106 administrator rated "not true" in the following statements.

- I am satisfied with the emphasis of this program on family involvement in student learning.
- I believe this program will increase student interest in STEM disciplines by the end of year 3.
- I am satisfied with the emphasis of this program on student STEM career interest.
- I believe this program will increase teacher professional growth by the end of year 3.

These findings show us that administrator of D106 held negative beliefs about the NES project and expressed skepticism about the possible benefits of the NES project on teachers and students. The NES D106 team consisted of three teachers and an administrator in 2003. In 2005, a new administrator came on board and with the new administrator came a shift in administrative support for NES. This may explain why the teachers did not complete the TLC survey in 2006. The findings reported in Brief 5 (Ruberg, Martin, & Chen, 2007) also indicate that the administrator who is not involved since the beginning of project seems to be more pessimistic about the impact of NES project on their teachers and students than those administrators who have joined the team for the last one or two years.

Although the D106 administrator was found to be skeptical about the NES projects, she seemed to have actively encouraged teachers to use NASA educational products in their classroom and support teacher attendance to professional development conferences and workshops.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
The D106 team purchased the following technologies with NES funding:

- Videoconferencing equipment
- Handheld computer microscopes
- Computers
- Projectors
- SMART Board™
- Culinary Math
- Robotics

The videoconferencing equipment was purchased using NES funds, but the D106 team indicated that it has never been used because members had no specific use for it in the strategic plan. The team's field center coordinator mentioned that the D106 school videoconferencing equipment has been broken and cannot be fixed. This might have hindered D106's participation in DLN events.

Outcome 3. Increased family involvement in children's learning.
The D106 team initiated several NASA-related events, such as family science and star nights. These events have been beneficial for both encouraging parental involvement and enhancing student learning.

"The star party was a success; we had 80 percent turnout. It was enormous" (Feb. 1, 2005).

"The school invited experts from NASA for science night. (They) brought materials and experts to the community and provided parents with outside lessons and experiences that, otherwise, they would not have had access to" (Feb. 1, 2005).

Searching for postings about D106 outreach and family events on the web, we found the following comments from parents of D106 students. In 2003 a parent was concerned about the school safety and environment for the children. In 2004 a parent suggested school climate was still the biggest concern for the students.

> "If you live within the boundaries of this school, do not send your child to this school. My wife and I have had a horrible experience at this school. The teacher my son has does not know how to teach a standard curriculum there. My daughter, fortunately, has a teacher who cares. The principal does not have 100 percent control over the operation of the school. He does not have enough staff to supervise the school and the children going to it. The school's front office staff is horrible, with the exception of one person there. Do not send your child to this school. You're better off with open enrollment at another school." (May 2004)

> "Fourth-graders eat lunch last, and once a week the school will run out of food to feed them, so they give them a piece of meat and milk. Second, the school did not meet the new student enrollment by five students, so a fourth grade classroom was closed, and the remaining students were herded like cows into existing classrooms, making it extremely overcrowded and unsafe and unhealthy for our children. Paraprofessionals are in the classroom only 1 hour and 20 minutes. Walking around in the fourth grade classrooms, you have to watch where you walk, or you will fall because it is extremely overcrowded. " (November 2003)

Outcome 4. Increased student interest and participation in STEM-G.
NES brought to the classroom NASA resources that students would not have experienced before NES. Refer to Table 4 for types of NASA resources that D106 teachers used in their classroom.

Respondents said kids are now more aware of what's happening around them and actually interpret why things happen the way they do. One respondent noted that some kids who graduated to middle school would come back and look for materials from the NES program.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teacher observation are provided after each strand.

Participate productively in STEM-G practices and discourse.

> "Students have interacted with scientists using the Cassini satellite to view a specific region of Saturn" (April 26, 2006).

Show noticeable curiosity in STEM-G-related topics and events.

> "The program has brought kids things to the classroom they would have never seen. They come in now saying, 'Did you hear about the comet?' They are actually looking and listening now to what's going on in the world" (Feb. 1, 2005).

Outcome 5. Increased student knowledge about careers in STEM-G.
NES provides opportunities, such as a student science symposium, for students to advance in their science abilities.

> "Two students went to a 4-5 day symposium that took place at Kennedy Space Center in Florida. They also spent a week with other NES schools' students and did workshops and learned from science experts and met astronauts. It made a huge impact on students, and they were treated like celebrities out there." (Feb. 1, 2005)

In searching for more information on D106 students' knowledge about careers in STEM-G, we examine D106 students' interest survey and summarize the key findings from it. When D106 students were asked about how much would they

like to have STEM-G careers, D106 students responded they would "like some"[1] having a career as a propulsion engineer with a mean score of 3.26. The average score for robotic engineer was also rated higher than other STEM-G careers with a mean score of 3.0. This shows us that teachers who use rockets may have influenced how students understand or like the career. In addition, when examining the mean scores based on a 5-point scale, it is encouraging to see students interests in STEM-G careers are above average (2.5).

Compare with non-STEM-G careers, D106 rated higher in having jobs as a secretary or teacher. This shows that D106 students' interest or knowledge in STEM-G careers still needs some improvement. Table 8 shows the means and standard deviation on the comparison of jobs that D106 students are interested in having.

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.

The following strands are indicators of increased student ability to apply STEM-G concepts and skills in meaningful ways. Examples from teacher observation are provided after each strand.

Understand, use, and interpret the nature and development of STEM-G topics.

> "One of the students was sort of notorious in the school, but he demonstrated in the science fair a rocket tree to show how rockets propel" (Feb. 1, 2005).
>
> "On the JPL Cassini mission a student was talking to NASA scientists about a very complicated subject. She's able to have a dialogue with professional scientists at a level which a teacher could not have ever predicted her to go up to" (April 26, 2006).

Demonstrate student performance increased in STEM-G and related subjects like language arts.

[1] The mean score of *like some* equals a rating of 3 out of 5, with 1 being *don't like* and 5 being *like a lot.*

> Students' improvement on the achievement was not as well as we would expect. While the teachers stressed bringing up students' math performance, D106 exceeded state averages in language arts for fourth grade in 2006 after being an NES school for more than three years, though the transition has been slow.

Tables 5, 6, and 7 show D106 students' achievement scores in math and language from 2003 to 2006. Figures 1 and 2 illustrate the comparison of D106 fifth grade student language arts achievement scores with district and state scores in 2006.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005
Student population	775	775	734
Black, non-Hispanic	33	34	31
Asian	61	58	52
Hispanic	607	613	594
Indian, Alaskan Native	1	1	1
White, non-Hispanic	73	69	56
School location (rural, suburban, urban, large central city)	large central city	large central city	large central city
School type (public, private, charter, magnet)	public	public	public
Title 1 status (yes or no)	yes	yes	yes
English language learners		472	470
Free and reduced price lunch	75.74%	76.13%	82.29%
Teacher population	42	19	38

Source: CCD Public school data for each school year, National Center for Education Statistics, Institute of Education Sciences.

Table 2. Summary of Academic Needs Identified by D106 in 2003

1	Earth and Space Science: Earth in the solar system
2	Physical Science: Transfer of energy
3	National Science Education Standards: Grades 5-8
4	The Uses of Geography: How to apply geography to interpret the past
5	The world in spatial terms: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information
6	Physical Science: Properties and changes of properties in matter
7	Life Science: Populations and ecosystems
8	Physical Systems: The characteristics and spatial distribution of ecosystems on Earth's surface
9	Human Systems: The characteristics, distribution, and migration of human populations on Earth's surface
10	Physical Science: Motions and forces

Table 3. NASA Professional Development Opportunities That D106 Teachers Completed

Orientation workshop
NSTA conference, Albuquerque, NM
FTTM conference, Salt Lake City, UT
JPL
Goddard Space Flight Center

Table 4. NASA (and NASA-affiliated) Resources Used

Cassini mission
Rockets

Table 5. NES D106 Math Achievement Scores

The team lead stated the school was on a list of poor performing schools in the state. But last year it came off the list because its scores increased. This is a table of comparison between NES D106 and state testing scores.

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
2		13	20	35	32
3		31	26	22	21
4		6	22	44	29
5	2003	23	33	34	10
2		6	15	37	42
3		26	21	31	22
4		13	27	34	25
5	2004	24	32	32	12
2		7	12	39	42
3		12	23	38	26
4		16	18	28	38
5	2005	26	23	37	15
2		6	15	36	43
3		16	19	33	31
4		16	19	28	38
5	2006	41	17	26	16

Table 6. NES D106 Language Achievement Scores

Grade	Year	Min. Language	Basic Language	Prof. Language	Adv. Language
2	2003	19	30	33	18
3		28	46	21	5
4		7	51	26	16
5		17	55	25	4
2	2004	15	26	42	18
3		41	33	22	4
4		15	46	31	8
5		18	43	29	9
2	2005	7	31	45	18
3		27	41	24	8
4		17	29	30	24
5		16	46	30	8
2	2006	6	31	37	26
3		23	42	25	10
4		16	29	34	20
5		29	38	22	11

Table 7: State Language Achievement Scores

Grade	Year	Min Language	Basic Language	Prof. Language	Adv. Language
3	2003	37	30	23	10
4		26	35	24	15
5		29	36	26	10
2	2004	35	30	23	12
3		39	31	21	9
4		27	34	23	16
5		29	31	24	16
2	2005	31	28	28	14
3		37	31	21	10
4		23	30	27	20
5		25	32	26	17
2	2006	27	27	28	19
3		32	32	24	12
4		23	28	25	24
5		26	32	25	18

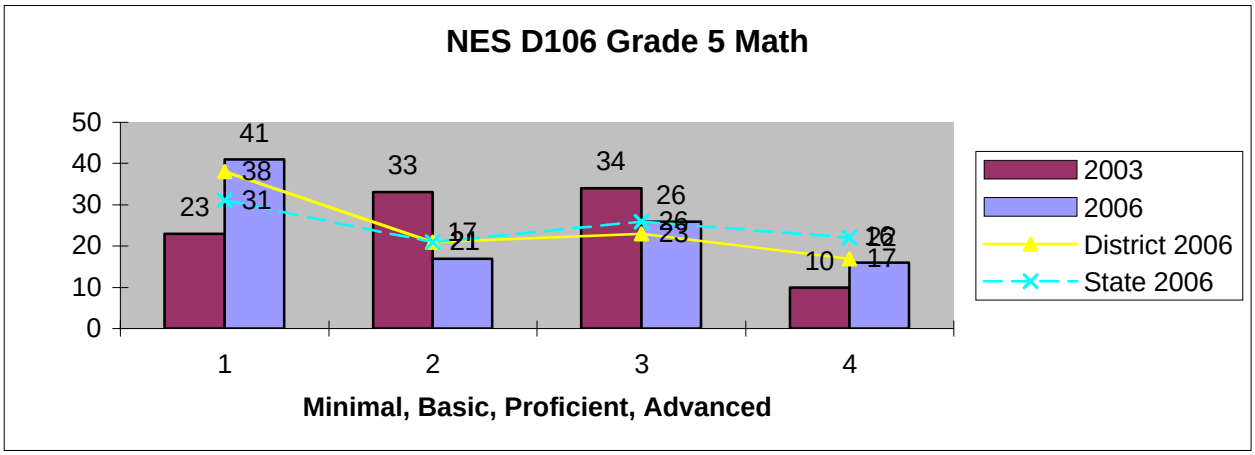

Figure 1. Challenges that NES D106 faces in trying to improve student math scores.

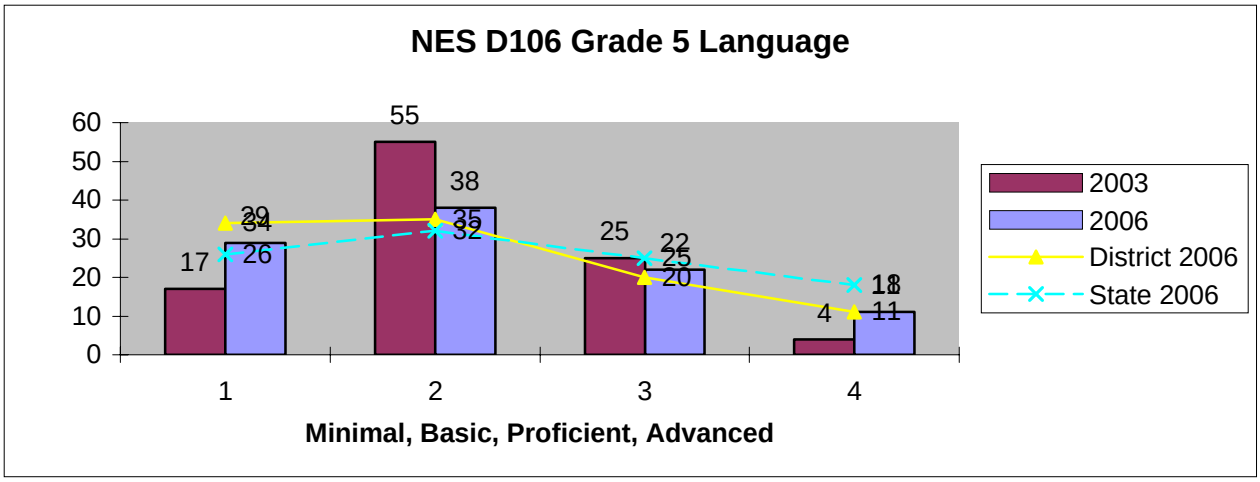

Figure 2. How NES D106 fifth grade student language arts achievement scores compare with district and state scores in 2006.

Table 8. Jobs that D106 Students are Interested in Pursuing.

STEM-G jobs

	M	SD
Chemical Engineers	2.91	1.26
Biologist	2.70	1.35
Oceanographer	2.89	1.30
Planetary Scientist	2.86	1.18
Robotic Engineer	3.00	1.26
Propulsion Engineer	3.26	1.59

Non-STEM-G jobs

	M	SD
Physician	2.19	1.37
Police Officer	2.92	1.04
Secretary	3.63	1.50
Teacher	3.36	1.18

NASA Explorer Schools Case Study Profile: E57
2003 Cohort—Urban Fringe of Mid-Size City, Mississippi Public Middle School: Grades 6-8

Summary Comments Regarding NES E57
NES E57 is a public middle school located in Mississippi. This school was selected as a NASA Explorer School in 2003. The school enrollment was 588 students during 2003-2004 and decreased to 312 in the 2005-2006 school year. In 2004-2005 about 67 percent of students were eligible to receive a free or reduced lunch based on their family income status. Special education students make up six percent of the school population. (See Table 1 for more details.)

We examine schoolwide achievements at E57 in terms of the extent to which its NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is primarily based on the transcripts of two focus group interviews conducted by telephone with the E57 NES team. The first interview was conducted on Feb. 15, 2005; the second, May 2, 2006. We have also used school web site, survey data, and Department of Education school data to expand upon information provided in the interviews.

Here are some of the accomplishments achieved by E57 over its three years as a NASA Explorer School:

- The E57 team has made efforts to involve and open opportunities for other non-NES teachers. The feedback from non-NES teachers has been positive and encouraging. Teachers now share their activities and strategies with each other, and their level of awareness and enthusiasm for science and science teaching have increased.
- The involvement of an administrator on the curriculum side has made the implementation processes easy. E57 is not only taking advantages of the instructional supports for teachers from NES, but also leadership support for the administrator.
- The E57 team found ways to increase community involvement through the media.
- Student math and language arts annual achievement test scores have steadily improved during the three years of the NES project. These improvements are documented in Tables 5-8.

E57 has addressed several challenges it has encountered with NES:

- The school has a hard time getting parents involved. Team members said the reasons might be either not getting the word out effectively or not developing programs that are really meaningful for the parents and families to interact with the students regarding NES activities.

- The field center is not as available as the E57 team would have liked. The team has been told that the field center had too many other schools and can only visit the school a small number of times.
- A natural disaster, Hurricane Katrina, caused delays in the implementation process. The help from the NASA field center was limited because it lost its workshop areas too. E57 also lost a lot of instructional time because of Hurricane Katrina.

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Outcome 1: Increased participation and professional growth of educators in science.
E57 team members have been the same since starting NES in 2003. The team meets once a month and communicates as frequently as needed using e-mail. The team meets to discuss planning activities, money distribution, and how it will disseminate information to the rest of the faculty.

E57 has sent teacher representatives to the summer workshops and conferences. The workshops that teachers attended covered astrobiology, physics, and geology content areas that specifically address some of their school needs identified in Table 2. Since then E57 has done some in-house staff development on e-Missions™, geography, algebra, and GLOBE. All teachers are now certified in some area of GLOBE. The team also provides professional development to all the teachers in the school and school district. Tables 3 and 4 list details of professional development opportunities and resources used by E57 teachers.

E57 has observed many positive outcomes from non-NES teachers. One of the biggest outcomes is non-NES teachers' voluntarily participation in the staff development and their enthusiasm about science and teaching in science.

> "Non-NES teachers have been very responsive, and each year teachers have reported out and shared their activities and strategies. There is a constant growth in the level of awareness and enthusiasm for science and teaching in science. One of the staff developments was on remote sensing and Echo the Bat. After teachers became aware of this program, they were able to use it in their classroom" (Feb. 15, 2005).

> "All of the teachers have been involved in staff development through the field center. Some of those teachers, e.g. language arts and social studies teachers, have used the programs that NASA has provided in very creative and unique ways for their own subject areas. It has widened teachers' spectrums on science, math, and technology. It [also] helps the teachers to teach math and science in a way that students can relate to and better help them to use those skills in real life situations" (May 2, 2006).

In addition, the benefits also extend to the administrator. The E57 principal said:

> "The [NES] program has enabled me as an instructional leader to be a truly instructional leader and bring areas of information and staff training to the staff in an area that I might have been weak in. My area of expertise is reading and language arts. The NES program also has given me some administrative support in the area of instructional leadership" (May 2, 2006).

The E57 team values the facilitations it receives from its regional field center. However, the team favors and interacts more with other NASA regional centers. The team lead mentioned that the team has more interaction with other NASA regional centers.

> "People from [other NASA regional centers] would come in and do a class, modeling inquiry-based learning. And the local regional center did not have time to do that for us" (Feb. 15, 2005).

> "Very limited support after Hurricane Katrina because they also lost their workshop areas. Before that they were instrumental when it came to staff development and helping other teachers to grow professionally" (May 2, 2006).

E57 has seen test scores increase, especially in math. According to the team lead, "We really think that the improvement is because of the Explorer School involvement" (Feb. 15, 2005). In 2006 the team also observed a significant gain in the math achievement test. "We attribute that in great deal to the NASA program" (May 2, 2006).

It has been difficult for E57 to get parents involved in school activities. The team found ways to improve the school publicity by using the media.

> "The school published [an article about] the robotics competition in the local newspaper with pictures. When we publicized FMA Live, we had

> local officials, state officials, and directors from NASA who came to the program at that time" (May 2, 2006).

In addition to our analyses from the NES case study, we report some key findings from the survey data on E57. The data we used in this case study analysis includes the teachers' Teaching, Learning, and Computing (TLC) survey and the team lead survey to identify consistencies or inconsistencies with our case study findings.

We were able to pair four teachers in E57 and compare them with the rest of the NES 2003 cohort teachers. Table 9 shows E57's mean and standard deviation on TLC surveys compared with NES 2003 cohort.

Table 9 shows that E57 teachers had lower perceptions of constructivist uses of technology and technical skills than other NES teachers while they reported more positive attitudes toward technology. This finding further supports our case study results, which indicate that even if teachers demonstrate positive attitudes toward technology, they are not yet equipped with sufficient knowledge about integrating technology to deliver the instruction effectively. This leads us to recommend that teachers should also be given professional development specifically on the integration of technology in their classroom.

In the team lead survey the E57 team lead recognized positive effects of the NES project on the school and students.

> "All of the team members see the benefit of being an NES school. We recognize that NES has helped us to deliver STEM-G concepts in the most meaningful way possible to our students. NES has given us the direction and focus that we needed as well as the resources needed to meet our goals."

The team lead rated "extremely satisfied" with NES team members and only "somewhat satisfied" with the involvement of the administrator as a team member.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
The E57 team purchased the following technologies with NES funding:

- Videoconferencing equipment
- Computers
- Projectors
- Robotics

The videoconferencing equipment was purchased using NES funds, but it was a disappointment. "It is broken and the school had to send it back. The center wants to charge us but the school does not have the money" (Feb. 15, 2005).

Outcome 3. Increased family involvement in children's learning.
E57 has initiated several family involvement activities since it started the NES project in 2003. The program has had a great impact on the community, particularly after Hurricane Katrina.

> "We have NASA days, Explorer School days on Saturdays where the parents can participate. The school wishes to do more later" (Feb. 15, 2005).
>
> "It has an impact on our community since Hurricane Katrina. One of the things about the NES program is that it brought the community out and together. We were able to vicariously bring healing and goodwill to the community" (May 2, 2006).

We found some E57 parent comments on the Internet that show both positive and negative views about the school. One of the parents commented that he or she is aware of the family activities for parent involvement. Another parent posted about liking the teachers and their teaching strategies. And there seems to be a mixed reaction to some school policies, such as uniforms.

> "I have a child in the eighth grade. This school has not only met my expectations, but has far exceeded them. To those parents who think the school policy is too harsh, you must not be living in the same world as the rest of us. Let your kids do wrong and they will. We all should thank the school for the fine job they are doing. I feel safe sending my child to school every day. We must only look at the test scores as compared to the state average. Keep up the excellent work" (January 2005).
>
> "First of all, I think it's not fair that we have to have a no jacket rule! If the issue about not wearing a jacket is because we can smuggle drugs, guns, etc., then what is the point of having on socks or having pockets on our pants? We can just as easily smuggle drugs in our socks or any other clothing spot just as we can in jackets. I think it is not fair that we cannot be who we really are because we are stuck with uniforms that make us all alike. I'm sure we kids would do a lot better in school knowing we are ourselves and not stuck with clothing chosen by other people. Who really cares what we're wearing anyway? So what's the point? As long as we get

good grades, it shouldn't matter what we wear. I do, however, like the extracurricular activities" (January 2005).

"This is my second year at the middle school and some of the rules are crazy!!!! First of all, the whole thing with no jackets I don't understand. Do not tell a student they may not wear a jacket if you are going to do it yourself. Why do we even have uniforms in the first place? A student should be able to express their individuality. We can't be wearing the same thing! This mandatory uniform policy needs to be removed. I heard there was a poll done for uniforms and that most of the parents wanted them. Have they done a poll since they issued a uniform policy? I doubt it!" (January 2005).

"I am very disappointed in this school system. They do not care about our children's education. All they care about is whether our children are wearing jackets or have their shirts tucked in! " (January 2005).

"My daughters both go to this school, and the rules are ridiculous. Mr. XXXX is irresponsibly not meeting my expectations as assistant principal. He needs to be taken out of assistant principal position and replaced by a less harsh and more forgiving person" (November 2004).

"(E57) is a pretty good school. The principal is great, but the rules are harsh. The no jacket policy is terrible, the rules of the cafeteria are even worse, and the skirt length is ridiculous. I am 5'4", and I have very hard problems finding a skirt long enough to fit. When I finally did find a skirt it was 4.4 cm in. Well, they had just changed it from 4 to 3 so it was even harder. I have gotten in trouble many times, and it is completely unfair because the shorter people can go to school with the butts hanging out, but the tall people constantly get picked on. This is a completely unfair rule. It needs to be changed to 5 or 6 in. above your knee. Another problem is unfair treatment. It's not fair that teachers can use cell phones, chew gum, and so on. The unfair treatment needs work " (October 2004).

"The teachers are first rate, and they strive to give your child the best education possible. I have never had a problem with a teacher, nor have I been disappointed in any teacher's teaching style" (September 2003).

"I have been very pleased with the middle school. The principal seems to be doing a fine job. The teachers are awesome. This is my daughter's second year there, and she loves it and loves the faculty. The office assistants are always personable, kind, and easy to work with. The nurse

> is always helpful. I only wish they would separate the soccer team as junior high and high school instead of the children always having to play high school. But maybe one day, more of the children are becoming interested in it. Parent involvement seems to be good. I'm not always at their meetings because I work two jobs, and the meetings seem to fall on the evenings I'm busy with work or my children's activities. The safety is as good as I think it can be. They are always looking for ways to improve, and I like that about this school. The overall quality has been outstanding for our family. Thanks! " (April 2003).

Outcome 4. Increased student interest and participation in STEM-G.
The use of NASA materials and technology has made differences in students' learning and their attitudes about STEM-G-related subjects. Students are interested in doing NASA-related activities such as e-Missions™. The learning environment for students is phenomenal.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teacher observation are provided after each strand.

Participate productively in STEM-G practices and discourse.

> "Students are interested in doing e-Mission and see the importance of math and science when doing the activity. It creates a whole lot of enthusiasm among students" (Feb. 15, 2005).

Show noticeable curiosity in STEM-G-related topics and events.

> "Kids enjoy the investigations into the other parts of the world. Like Rockets got kids very interested in thinking about Newton's Laws" (May 2, 2006).

Change attitudes about learning.

> "Two groups of students are getting ready to do e-Mission, and they show much interest and see the importance of math and science in doing this kind of activity" (May 2, 2006).

Actively participating in hands-on and authentic scientific research.

> "We have done amusement park physics where students are involved in developing roller coasters, watching the transfer of energy, and investigating kinetic and potential energy in a real life situation" (Feb. 15, 2005).

Outcome 5. Increased student knowledge about careers in STEM-G.
NES provides activities that challenge students to see the importance of science and math in their everyday lives. It has helped students to become familiar with the kinds of careers that are available at NASA.

> "A lot of activities challenge the students to see that science and math is important in their everyday lives, and a lot of students maybe think about science and math for careers, specifically NASA, which is science and math careers in general" (Feb. 15, 2005).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.
E57 team members have observed students' achievement tests improve and have been sending students to the science symposium.

> "Students' test scores improve dramatically, especially in math (haven't have science tests yet). The team lead said, 'We really think that the improvement is because of the Explorer School involvement.' The score went from level 4 to level 5, which was the highest you can get. Our MCT score went from level 4 to 5. There is a significant gain in math, and 'we attribute that in great deal to the NASA program' (Feb. 15, 2005)."

Tables 5-8 document E57 students' math and language achievement tests.

> "We have been to the student symposium for the two years past, but not this year because we don't really have a feasible thing to do this year. Another reason is that we lost a lot of instructional time due to the weather, and the testing is coming up" (May 2, 2006).

NASA Explorer Schools Case Study Profile: E57

2003 Cohort—Urban Fringe of Mid-Size City, Mississippi Public Middle School: Grades 6-8

Table 1. School Demographics

	2003-2004	2004-2005	2005-2006
All students	588	620	312
Black, non-Hispanic	125	138	45
Asian	10	7	4
Hispanic	11	10	3
American Indian, Alaskan Native	1	0	0
White, non- Hispanic	441	465	260
School location (rural, suburban, urban)	urban fringe of mid-size city	urban fringe of mid-size city	
School type (public, private, charter, magnet)	public	public	
Title 1 status (yes or no)		yes	
Special education students	21	17	11
Free and reduced price lunch		67.1%	

Table 2. Summary of Academic Needs Identified by E57 in 2003

1	Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement
2	Measurement: Apply appropriate techniques, tools, and formulas to determine measurements
3	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.
4	Life Science: Populations and ecosystems
5	Problem Solving: Apply and adapt a variety of appropriate strategies to solve problems
6	Design: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
7	Number and Operations: Compute fluently and make reasonable estimates
8	Physical Science: Motions and forces
9	Connections: Recognize and apply mathematics in contexts outside of mathematics
10	The World in Spatial Terms: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information

Table 3. NASA Professional Development Opportunities That E57 Teachers Completed

Orientation workshop
Summer workshop in astrobiology
GLOBE
e-Mission
Jason Project

Table 4. NASA (and NASA-affiliated) Resources Used

e-Mission
Robotics
Lunar Challenge
Rocket launch
Amusement park physics
NASA web site

Table 5. NES E57 Math Achievement Scores

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	11.8	17.6	30.6	40
7		18.2	16.9	31.8	33.1
8		9.7	18.1	34	38.2
6	2004	2.9	8.7	40.5	48
7		18.7	15.2	23.7	42.4
8		16.2	16.2	37.1	30.5
6	2005	13.5	12.9	24.7	48.8
7		14.4	16.4	32.3	36.9
8		18.2	24.6	27.1	30
6	2006	10.9	9.2	23.5	56.3
7		22.4	14	27.1	36.4
8		10.7	16.8	38.2	34.4

Table 6. NES E57 State Math Achievement Scores

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	18.3	19.9	30.7	31.1
7		30.1	17	29.9	23.1
8		27.1	24.8	27.3	20.8
6	2004	12.7	16.5	34.6	36.2
7		29.4	16.9	24.2	29.5
8		17.7	22.6	36	23.7
6	2005	14.5	17.6	30.7	37.2
7		24.2	16.3	31.3	28.1
8		22.4	24.5	29.2	23.9
6	2006	15.2	12.2	30.2	42.4
7		25.4	17.2	28.7	28.6
8		21.4	19.5	32.6	26.5

Table 7. NES E57 Language Achievement Scores

Grade	Year	Min. Language	Basic Language	Prof. Language	Adv. Language
6	2003	4.8	27.7	51.2	16.3
7		4.6	44.4	38.6	12.4
8		2.1	28.2	52.8	16.9
6	2004	1.7	25.9	58	14.4
7		3.6	24.4	50.8	21.2
8		4.8	36.7	47.6	10.8
6	2005	5.3	24.1	44.1	26.5
7		5.2	33	47.9	13.9
8		5.9	34.7	52	7.4
6	2006	8.4	30.3	45.4	16
7		9.3	32.4	42.6	15.7
8		3.8	32.1	45.8	18.3

Table 8. NES E57 State Language Achievement Scores

Grade	Year	Min. Language	Basic Language	Adv. Language	Prof. Language
6	2003	7.5	30.9	46.7	14.9
7		8.2	39.8	39.8	12.1
8		7.5	39.2	42.9	10.4
6	2004	5.6	32.6	47.6	14.2
7		5.3	30.8	44.5	19.4
8		6	42.6	40.7	10.7
6	2005	6.1	28.8	48.1	17
7		7.8	38.1	40.6	13.5
8		6.9	38.1	43.9	11.2
6	2006	6.8	30.2	45.9	17.1
7		7.6	35.8	46	10.6
8		7.5	42.3	39.8	10.4

Table 9. Comparison of E57 and 2003 Cohort Teachers

	E57		2003 Cohort	
	M	SD	M	SD
Constructivist Teaching Philosophy (CTP)	3.11	0.29	3.29	0.4
Constructivist Teaching Strategies (CTS)	2.39	0.47	2.73	0.6
Constructivist Uses of Technology (CUT)	1.72	0.32	2.73	0.56
Technical Skills (TS)	2.58	0.17	2.99	0.49
Attitudes Toward Technology (ATT)	2.99	0.28	2.17	0.75

NASA Explorer Schools Case Study Profile: F18
2003 Cohort—Mid-size City, New Mexico Public Middle School: Grades 6-8

Summary Comments Regarding NES F18
F18 is a middle school located in a mid-size city in southern New Mexico. About 65 percent of the students are Hispanic, and a large percentage of these students are English as second language learners. The school enrollment was 921 during 2003-2004 and decreased to 914 in the 2004-2005 school year. In 2003-2004 about 60 percent of students were eligible to receive a free or reduced lunch based on their family income status. In 2004-2005 the percentage of students eligible to receive a free or reduced lunch decreased to 46 percent. The percentage of teachers certified as "highly qualified" increased from 27 of 54 in the first year of NES to 50 of 53 in the second year of NES. (See Table 1 for more details about the school demographics.)

We examine schoolwide achievements at F18 in terms of the extent to which its NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is based primarily on the transcripts of two focus group interviews conducted by telephone with the F18 NES team. The first interview was conducted on March 1, 2005, and the second, April, 26, 2006. We have also used school web site, survey data, and Department of Education school data to expand upon information provided in the interviews.

Here are some of the most outstanding accomplishments achieved by NES F18 over its three-year period as a NASA Explorer School:

- The NES F18 team has involved special education teachers and students in the NES program. The F18 team perceives that the involvement of the entire school population as one of the important goals of the NES team. F18 non-science teachers are doing interdisciplinary study with students.
- The team members at F18 have sought out opportunities offered at the local university and continue to build scholarly activities through this partnership.
- The F18 team has actively disseminated information to non-NES teachers. For example, helping other teachers to apply for different opportunities and sharing information and resources.

The F18 team has addressed several challenges it has encountered with NES:

- Changes administration has slowed down the implementation process. It takes a while for the new administration to get acquainted with the NES project.
- The late arrival of NES funding has caused problems in the school's ability to implement its NES plans. F18 needs more funding than what is available for them.

NASA Explorer Schools Case Study Profile: F18
2003 Cohort—Mid-size City, New Mexico Public Middle School: Grades 6-8

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development workshop teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Outcome 1. Increased participation and professional growth of educators in science.
The NES team at F18 reformed slightly since the project's inception. The 2003 team lead moved on to be the principal. A science teacher from the original team moved to the team lead position. In 2006 F18 consisted of four team members, including a principal and administrator. See Table 2 for the list of needs identified by F18 in 2003.

The F18 team has attended several workshops and conferences to learn about STEM-G-related content knowledge. Teachers have gone to Cape Canaveral, FL; Space Camp at Huntsville, AL; robotics training at Houston, the History of Winter conference at Lake Placid, NY; and Yellowstone Park. They also have teachers who participated in the Reduced Gravity Opportunity Flight. See Table 3 for the list of NASA professional development opportunities F18 teachers completed.

The F18 team has expanded the project and disseminates information to other non-science teachers. The number of members in F18 has been growing profoundly. F18 team members meet weekly to plan implementation. "When pressed [the team has expanded to] 48 members– 12 science, 12 math, 12 language arts, and 12 social studies teachers" (April, 26, 2006). F18 team members have made many NASA resources and workshops available to other non-NES teachers. In 2005, F18 has "social studies and language arts teachers [are] excited about implementing science topics. Teachers are doing interdisciplinary units. They are given the opportunities to receive professional development that they would not have otherwise been able to attend due to funding constraint" (March 1, 2005). In 2006, "the entire school population was included in the team efforts to get schoolwide adoption of the program, and this included teachers who are special education. This may seem like a minor point, but it was very important at [F18]" (April 26, 2006).

In 2005 the F18 school administrator responded with "no personal impact" when surveyed about participating in NES. Hence, he perceived the benefits of NES as for the teachers and students. He said the school sent "a couple of students to Houston based on a competition on why they would want to be an astronaut. So

it affected their lives" (March 1, 2005). His understanding of the NES program is that its objectives are to expose students and minorities to occupational opportunities they might not have otherwise. Like some of other NES schools, the F18 team has encountered problems with changes in the administration. "We [F18] changed the administrator. [The previous administrator] she knew it [NES] more in depth and was also was tied into the original application for the program" (March 1, 2005). The team lead also stressed the late arrival of funding has caused problems with the implementation process. "The late arrival of funding was a problem. We also had things that required more funding than was available" (April 26, 2006).

The team has been trying to build partnerships with a local university. The school has a collaborative relationship with Texas A&M, the U.S. Department of Agriculture, NASA and SEM Satchel on an experiment. In 2006 F18 also had collaborated with University of Texas at the sustainability conference.

F18 failed to complete the teacher TLC and team lead surveys. Therefore, we did not have numerical data to report as triangulation of case study findings.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
The F18 team purchased the following technologies with NES funding:

- Videoconferencing equipment
- GPS units
- Science supplies
- Probes

The videoconferencing equipment was not working properly the first time because of the firewall. The second time was successful. The school was able to have an hour-long videoconference on reduced gravity flight between 12 students who are members of the ground crew at the school site and the teachers on the flight.

Outcome 3. Increased family involvement in children's learning.
The F18 team has worked with parents to support their middle school children. F18 also sponsors other non-NASA activities.

"We have a parent who is also the White Sands test facility education specialist. He helped out a lot with the ionization airfoil experiment. He was great working with the kids. He doesn't just do one thing. He is committed and follows through. He brought a huge display from the microgravity flight. He did a report

that explained the experiment that is available in our school library" (April 26, 2006).

"At the last parent night, attendance was about 350 parents. The school brought in guest speakers, psychologists to speak to parents about study skills, and how to support their kids" (March 1, 2005).

"Family activities are held once every nine weeks and include guest speakers, dinner, and an assembly" (April 26, 2006).

Searching for postings about F18 outreach and family events on the web, we found the following comment from a parent. In 2004 a parent complimented the F18 school and teachers. "One of the greatest schools in --------. The greatest middle school there!" (May 2004).

Outcome 4. Increased student interest and participation in STEM-G.

The NES F18 team observed students' reaction to some of the NASA activities such as e-Mission™. They found that the activity engages students in something that's real world and such learning experience cannot be found in the normal classroom or textbook. The teachers also observed that students are paying more attention to the real-world events.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teacher observation are provided after each strand.

Participate productively in STEM-G practices and discourse

> "One of our NES teams today did the e-Mission™ for Operation Montserrat, and we had 100 kids involved in the activities. I saw those kids tracking hurricanes, watching volcanoes, evacuating people, working together to solve problems, using math and science, and being careful about how they are writing. It engaged them in something that is real, not out of a book. It was awesome and the most incredible day" (April 26, 2006).

Show noticeable curiosity in STEM-G-related topics and events

> "Students are now talking about how they watch the space station go over at night, and they publish what and when it is. The kid that you least expected might come in the next day and say 'I saw it, and it was really cool' " (April 26, 2006).

Outcome 5. Increased student knowledge about careers in STEM-G.
No specific evidence was found that directly linked to the increase of student knowledge about careers in STEM-G. However, the NES F18 administrator observed that "[NES has] very specific applications out there that we can offer students to see why they are learning and helping them make those connections" (April 26, 2006).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.
F18 students are actively involved in doing science projects for the school science fair. F18 has sent students to the national competition and received high scores, which shows that their ability to apply STEM-G concepts and skills has improved a lot.

"In the NASA science night, almost everybody did a science fair project and they were lined up throughout every hallway, throughout the school and classroom, and into the small gymnasium" (April 26, 2006).

"Students participated in regional science competition" (April 26, 2006).

"We had a group of students who went to Math Olympiad, and they scored very highly in the competition there and came back very enthusiastic" (April 26, 2006).

Tables 5-8 shows F18 students' math and reading achievement scores and compares them with the district and state achievement scores. In 2005's math achievement test results, 20% of students were in beginning step category; 51% were in the nearing proficiency category; 23% categorized as proficient; and 2% were classified as advanced for 7th graders. In 2006, there were 16% of students who were in beginning step; 52% were in nearing proficiency; 27% were in proficient; and 3% were in advanced for 8th graders. By the year of 2006, more sixth and eighth grade students were at the nearing proficiency or proficient levels than in 2005.

NASA Explorer Schools Case Study Profile: F18
2003 Cohort—Mid-size City, New Mexico Public Middle School: Grades 6-8

Table 1. School Demographics

	2003-2004	2004-2005	2005-2006	2006-2007
All students	921	914		902
Black, non-Hispanic	20	17		
Asian	2	0		
Hispanic	577	587		
American Indian, Alaskan Native	4	4		
White, non-Hispanic	318	306		
School Location (rural, suburban, urban)	mid-size city	mid-size city		
School Type (public, private, charter, magnet)	public	public		
Title 1 status (yes or no)	no	no**		
Free and Reduced Price Lunch	60.0%	46.5%		50.22%

NASA Explorer Schools Case Study Profile: F18
2003 Cohort—Mid-size City, New Mexico Public Middle School: Grades 6-8

Table 2. Summary of Academic Needs Identified by F18 in 2003

1	The World in spatial Terms: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information
2	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
3	Design, develop, publish, and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom
4	Number and Operations: Understand numbers, ways of representing numbers, relationships among numbers, and number systems
5	Algebra: Understand patterns, relations, and functions
6	Physical Science: Motions and forces
7	Technology and Society: Students will develop an understanding of the effects of technology on the environment
8	Physical Science: Transfer of energy
9	Human systems: The characteristics, distributions, and complexity of Earth's cultural mosaics
10	Design: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving

Table 3.
NASA Professional Development Opportunities that F18 Teachers Completed

Orientation workshop
Robotic training
Space camp at Huntsville
History of Winter
LEGO Flight
Reduced gravity flight

Table 4. NASA (and NASA-affiliated) Resources Used

e-Missions
Rockets
Microgravity
DLN

NASA Explorer Schools Case Study Profile: F18
2003 Cohort—Mid-size City, New Mexico Public Middle School: Grades 6-8

Table 5. NES F18 School Math Achievement Scores

Year	Grade	Beginning Step	Nearing Proficiency	Proficient	Advanced
2005	6	24.6%	54.5%	16.2%	2.0%
	7	20.8%	51.4%	23.3%	2.2%
	8	19.9%	59.9%	17.8%	1.4%
2006	6	18.2%	60.6%	16.9%	4.2%
	7	25.1%	48.8%	22.7%	3.1%
	8	16.1%	52.6%	27.3%	3.3%

Table 6.
NES F18 Comparison of School, District, and State Math Achievement Scores

Year	School	Beginning Step	Nearing Proficiency	Proficient	Advanced
2006	State wide	18.0%	48.2%	26.8%	5.2%
	District wide	16.1%	49.9%	27.9%	4.9%
	School	19.7%	54.1%	22.3%	3.5%
2005	State wide	-	-	-	-
	District wide	17.0%	51.5%	25.6%	4.3%
	School	21.7%	55.2%	19.2%	1.9%
2004	State wide			50%	
	District wide	-	-	53%	
	School	-	-	63%	

Table 7. NES F18 School Reading Achievement Scores

Year	Grade	Beginning Step	Nearing Proficiency	Proficient	Advanced
2005	6	7.1%	44.1%	43.8%	3.0%
	7	6.0%	34.1%	51.7%	6.0%
	8	7.2%	39.0%	51.4%	1.7%

2006	6	4.2%	47.2%	44.3%	3.9%
	7	7.6%	34.4%	52.9%	4.8%
	8	5.9%	35.9%	53.3%	4.3%

Table 8. NES F18 Comparison of School, District, and State Reading Achievement Scores

Year	School	Beginning Step	Nearing Proficiency	Proficient	Advanced
2006	State wide	13.3%	35.1%	43.7%	7.1%
	District wide	13.0%	34.3%	44.2%	7.4%
	School	5.9%	39.2%	50.1%	4.3%
2005	State wide	-	-	-	-
	District wide	13.1%	33.7%	43.8%	7.3%
	School	6.7%	39.0%	49.0%	3.6%
2004	State wide	-	-	53%	
	District wide	-	-	59%	
	School	-	-	68%	

NASA Explorer Schools Case Study Profile: G145
2003 Cohort—Southern California Public Middle School: Grades 6-8

Summary Comments Regarding NES G145
NES G145 is a public, suburban middle school in Southern California serving grades 6-8. The student population has grown more diverse since its 2003 acceptance into the NES project. This is a Title 1 school that has been experiencing rapid population growth—especially in non-native population groups and lower income families. (See Table 1 for more details.)

Here are some of the successes achieved by NES G145 has achieved as a NASA Explorer School:

- According to the NASA field center staff providing support for G145, the school had its biggest breakthrough during the 2004-2005 school year. Twice that year the school had block schedule days in which it selected a STEM-G topic and had that topic integrated through the entire school with all teachers basing their classroom lessons that day on the topic. In the fall the topic was aeronautics; in the spring it was microgravity. The entire school got involved.
- G145 has had consistent NES team leadership and stability. The team lead is a grade 6-7 science teacher; team members have been the same since 2003. The team meets once a month formally to plan, to discuss how money will be spent, to order materials, and to coordinate upcoming programs. The team works together in the school to lead, create, and apply the NES program, and the team tries to involve other teachers and ensure it's properly staffed.
- Student math and language arts annual achievement test scores have steadily improved during the three years of the NES project. These improvements are documented in Tables 5 and 6 and in Figures 1 and 2 presented at the end of this document.

The NES G145 team has addressed several challenges it encountered with NES:

- Because G145 lags behind the state average achievement scores, it has had restrictions on how it can incorporate NASA activities into classroom teaching. Teachers have to find ways to make things work with the California state standards. Sometimes it needs to adjust the NASA materials and resources to more closely match state guidelines.
- The G145 team has experienced some challenges associated with having five personalities work together so closely. Attempts to build schoolwide collaborations have not always been successful. Some team members reported a lack of cooperation from the staff, which was frustrating.

- Funding sometimes became a barrier. For example, a program that involved job shadowing scientists got bogged down in how people were going to charge their shadowing time.
- Population changes in the area surrounding the school impact the school student and family participation. Parental involvement is very difficult because some parents live 30-40 minutes from the school. The ethnicity of the school population is changing, and there has been a large teacher turnover in the past two years. Of 40 teachers, 17 are new. The school district is opening lots of "portable schools" in the region to address the changing population. School enrollment is increasing so fast that the sixth grade is moving back into the elementary school.
- Teachers report that NASA is consistent about requesting documentation data about program activities and the level of teacher, student, and parent participation. The expectations for reporting and documentation for NES were realistic, but sometimes the paperwork was difficult to manage, especially with other school duties and obligations.

We examined schoolwide achievements at G145 in terms of the extent to which their NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is based primarily on the transcripts of two focus group interviews conducted by telephone with the G145 team. The first interview was conducted on Feb. 16, 2005, and the second, April 27, 2006. We have also used school web site, survey data, and Department of Education school data to expand upon information provided in the interviews.

Outcome 1: Increase participation and professional growth of educators in science.

Teacher excitement level is what the field coordinator sees as one of the tangible effects of the NES project on G145 teachers. Teachers have demonstrated growth in their content and pedagogy, but the change is most evident in their level of excitement about what they are teaching. The field center education staff has observed that G145 teachers are more self-motivated and that this has had a "domino" effect at the school level (Field Center Staff Interview, 2005).

The NASA Explorer Schools project is set up to apply this model to teachers at schools who are in most need of science, technology, engineering, mathematics, and geography training and professional development support. By working with schools that have Title I status and a high minority enrollment, the NES program is specifically targeting the schools that need help and may not otherwise have

easy access to the expertise, resources, and external partnerships that NASA provides.

The next section examines the extent to which the G145 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Content. Participants are immersed in models of instruction that address these four aspects of science proficiency: (a) know, use, and interpret scientific explanations of the natural world; (b) generate and evaluate scientific evidence and explanations; (c) understand the nature and development of scientific knowledge; and (d) participate productively in scientific practices and discourse.

This team has reached out for NASA materials that could support inquiry learning, such as Signals of Spring, but the team has had to pull back on its implementation of these inquiry activities because of the need to focus more closely on basic skills. This school has experienced changes in population with demographic shifts to higher numbers of Spanish-speaking students and families along with rapid increases in enrollment. The increase in new teachers (12 new teachers hired in 2006) also makes implementation of inquiry teaching practices difficult. The school has tried to address this challenge by trying to offer enrichment programs that will return inquiry activities that had to be removed and teaching STEM-G subjects within an "academy" program where students stay with the same teacher through their middle school years.

Guideline 2. Coherence. The professional development is intensive and sustained.

This NES team has taken advantage of many of the professional development offerings. Its implementation of what it has learned from these professional development experiences is evident in the changes in curriculum and teaching strategies at this school. The team has had a consistent team lead and one teacher member throughout its participation in NES. This team, however, experienced inconsistent support from its NASA field center staff. The teachers report that during years one and three they received little to no support from their field center. The support in year two was tremendous and greatly helped the school in its implementation. The teachers felt that not having support in year three was less of a problem because the support they received in year two helped them understand and successfully implement professional development opportunities on site. Based on year two support, the NES team believes that it was able to

initiate changes in teaching practice that it was able to sustain on its own in year three.

Guideline 3. Active learning. The professional development engages teachers in concrete teaching tasks that are based on the teachers' experiences with students.

The team's experiences portrayed in the 2005 and 2006 focus group interviews show that the teachers and administrator were forced to be very attentive to how their teaching helped students achieve California state standards in language arts, math, and science. After three years in the program, the teachers identified which activities most closely addressed the state standards and which ones had to be classified as enrichment activities. The teachers showed a high level of awareness of what they needed to do in their classrooms to help their students improve in the areas that were most closely scrutinized and tested.

Guideline 4. Content. Professional development focuses on subject matter knowledge and deepens teachers' content skills.

In terms of teacher benefits, this group agrees that, "the [NES] money is nice, but the big benefit has been the programs…" and "…[The NES] experiences have opened doors that I was not aware were even out there." The teachers suggest that new schools need lots of guidance to be able to take advantage of the content and materials effectively. School teams need guidance in how to use NASA materials properly and how to plan and integrate NASA services. G145 team members believe that they had helpful guidance in year two of the program, but that this same support was unavailable to them in years one and three. Tables 3 and 4 summarize professional development opportunities and NASA resources used by G145 teachers.

Guideline 5. Active learning. The professional development is grounded in a common set of standards and must show teachers how to connect their work to specific standards for student performance.

The NES program is geared primarily to address national standards, so this school team had to adapt materials and resources to fit state and school requirements. This was a time-consuming process that required some classroom testing and team discussion. This is a strong teacher team, and not all schools would have had the determination and capabilities to take the time and intellectual effort required to select those activities that best fit the school's needs.

It appears that the aerospace education specialist who worked with the school in its second year greatly helped the team in this process. Table 2 summarizes G145 academic needs.

Guideline 6. Coherence. Reform strategies are connected to other aspects of school improvements.

The idea of moving to a school-within-a-school model where students have the same teacher for multiple years is a reform strategy that this school is using to address school needs that also match NES goals—implementing new STEM-G-related programs and activities and increasing parent involvement.

In addition to our analyses from the NES case study, we report some key findings from the G145 survey data. These data shed light on the case study analyses and serve as data triangulation with our case study findings.

In G145 we were able to pair three teachers and compare them with the rest of the NES 2003 cohort teachers. Table 7 illustrates G145's mean and standard deviation on Teaching, Learning, and Computing surveys compared with the NES 2003 cohort.

While G145 teacher mean scores were not in agreement with constructivist uses of technology, their attitudes toward technology were higher than other NES school teachers. (See Table 7 for more details.) One of the biggest benefits of being an NES school is receiving technology support. Teachers report that they were able to attend professional development workshops and learn about different technology-enhanced programs that they could use in their classrooms. However, they demonstrated little to no knowledge of how to integrate the technology effectively and constructively. Indeed, teachers need more guidance and support in terms of how to plan and integrate the technology properly.

In the Team Lead survey the team lead reported that the implementation plan has not been used among the NES team and that NES did not meet most of the team's expectations. This relates to what team members mentioned during the interview about lack of funding causing implementation delays and frustrating team members and other teachers.

Outcome 2: Increased assistance for and technology use by educators in schools with high populations of underserved students.

NASA Explorer Schools Case Study Profile: G145
2003 Cohort—Southern California Public Middle School: Grade 6-8

G145 purchased the following technologies with its NES funding.

- Video camera
- Digital camera
- Computer equipment
- TV DVD
- Projector
- Robotics
- Rockets
- LEGO Kits

In terms of videoconferencing teachers reported, "We have made connections for our students through a live chat with the International Space Station. We have utilized DLN a number of times for our students" (Feb. 16, 2005) for the C-9 experiment and the Down to the Antarctic project.

As far as integrating the new technologies into their instruction, teachers reported that having the NASA materials was key to their being able to make effective use of the new tools and resources:

> "The stuff [the] school gets doesn't mean anything if they cannot use them with NASA. The distance learning stuff [is one] example" (Feb. 16, 2005).

Outcome 3: Increased family involvement in children's learning.
G145 has initiated NASA activities and events to promote family and community involvement. Here are teacher descriptions of the kind of events they have offered to increase family involvement and parent responses.

> "We have astronomy night where parents bring their students. People from the field center also come out to help us. In our astronomy night NASA people and several teachers brought telescopes. They taught us how to use them. Nobody left before it was time to close down" (Feb. 16, 2005).

> "We now have family nights and have a few parent groupies where before we had none. Parents are asking where they can buy telescopes" (Apr. 24, 2006).

Promoting family and community involvement at G145 is difficult because of transportation issues and the dramatic increases in non-English speaking families that have recently moved to the school's surrounding neighborhoods.

> "Parental involvement is difficult because some parents live 30-40 minutes away from the school. We get only 10-15 parents to join the PTA out of over 1,000. In grades 6-8 parents send us the kids and think that they are our problem. There are 3-4 families living in one home. The ethnic group is changing. In previous year we had around six blacks, 30-40 Hispanics, and the rest were rural white. Now we have 25 percent blacks, 25 percent white, and 50 percent Hispanic with a very low socioeconomic level" (Apr. 24, 2006).

> "The first year we had grandiose plans. We wanted to create programs and increase parent involvement. We have evolved to more of the nuts and bolts. Now our goals are more focused on how to achieve these things. Parent involvement was very difficult. We have parents living in paper shacks 30 to 40 minutes away from the school" (Apr. 24, 2006).

A new school program in which students have the same teacher throughout their three years in middle school has been implemented to improve communication between parents and teachers.

We found some G145 parent comments on the Internet, which show overall positive views about the school by the parents and an awareness that this is a NASA Explorer School:

> June 2006: "They had a shortage of teachers when I went there, and I didn't have a homeroom teacher till the very end of the year. There were numerous fights and only one security guard, but he did his job well. (G145), with the exception of some incidents, is a good place to learn and has a variety of sports available."

> August 2003: "I love the fact that this is a NASA school. I don't like the fact that they only offer four sports for the kids to play. My kid is one that needs to be in sports, but I can't afford to put him in outside school sports. Hopefully you will add more soon. Other than that, I like this school so far (son just started sixth grade). "

Outcome 4: Increased student interest and participation in STEM-G.
NES provides students many opportunities to explore outside of their normal classrooms. G145 students had the opportunity to visit real scientists and use telescopes. Students have shown great interest and anticipate more about NASA-related news and events.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teachers' observations are provided after each strand.

Participate productively in STEM-G practices and discourse.

> "Kids love the distance learning programs with Johnson and Langley. NASA people have been here to work with students on things like telescopes. We were able to name an airplane, which was a writing contest, which went off really well. A thousand kids entered it" (Feb. 16, 2005).

Show noticeable curiosity in STEM-G-related topics and events.

> "Every time NASA does something, the kids know what is going on. They know what's going to happen. They seem to be more aware of NASA and follow it" (Feb. 16, 2005).

Actively participate in hands-on and authentic scientific research.

> "In the aeronautics day kids learn about building planes and things like drag and lift. Kids love hands-on stuff" (Feb. 16, 2005).

Outcome 5: Increased student knowledge about careers in STEM-G.
NES has changed the way G145 students see themselves. They show more positive attitudes toward their future careers. Students get to use the NASA materials and are able to give presentations about them. The program has increased students' understanding of STEM-G careers.

The following strands indicate students' knowledge about careers in STEM-G. Students who demonstrate knowledge about careers in STEM-G also demonstrate:

Changes in self-identity.

> "Minority students think about being an aerospace engineer or scientist. Kids now say their favorite class is math and that hasn't happened in a while" (April 27, 2006).

Increase understanding of and enthusiasm about STEM-G careers

> "The kids are doing their presentations on careers, and they can get most of their information from the NASA web sites" (Feb. 16, 2005).

> "The teachers have brought in more career-oriented science things to allow kids to know what the careers are in science, what is available to them, and what they have to do to get there. Let the students participate in some of the careers and act as actual scientists. For example, things like robotics where the kids actually get to pretend that they are engineers putting things together and getting them to work. The students also get exposed to the real engineers when they come up to meet with us or we go on field trips to meet with them" (Feb. 16, 2005).

Outcome 6: Increased student ability to apply STEM-G concepts and skills in meaningful ways.

G145 teachers have noticed the changes on students' achievement tests in reading, language arts, and science.

> "We have seen incredible growth in reading, language arts, and science. Tests include: Accelerated Reader, CAT6, Stanford, and STAR test for reading" (April 27, 2006).

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005
Student population	950	1,019	1,014
Black, non-Hispanic	236	267	266
Asian	25	7	19
Hispanic	359	426	454
Indian, Alaskan Native	3	8	5
White, non-Hispanic	322	291	264

NASA Explorer Schools Case Study Profile: G145

2003 Cohort—Southern California Public Middle School: Grade 6-8

School location (rural, suburban, urban)	urban fringe of large city	urban fringe of large city	urban fringe of large city
School type (public, private, charter, magnet)	public	public	public
Title I status (yes or no)	yes	yes	yes
Free and reduced price lunch	65.70%*	48.80%*	73.20%*
Teacher population	39*	43*	42*

*NCES. (2003, 2004, 2005). Search for public schools. Retrieved Jan. 18, 2007.

Table 2. Academic Needs (as outlined in 2004)

1	Design, develop, publish, and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom
2	The Nature of Technology: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study
3	Physical Science: Transfer of energy
4	Life Science: Populations and ecosystems
5	Physical Systems: The physical processes that shape the patterns of Earth's surface
6	Connections: Recognize and apply mathematics in contexts outside of mathematics
7	Use content-specific tools, software, and simulations to support learning and research
8	Measurement: Apply appropriate techniques, tools, and formulas to determine measurements
9	Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum.
10	Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement

Table 3. NASA Professional Development Opportunities that G145 Teachers Completed

Regional NES symposium
NES update session
NES special events
Regional conferences (NASA-funded)
National conferences (NASA-funded) [NSTA national, Anaheim, CA; NSTA, Seattle]
Summer orientation workshop
Summer content workshop
Summer sustainability conference
Kansas City robotics and technology convention

Table 4. NASA (and NASA-affiliated) Resources Used

NASA STEM-G activities
NASA STEM-G materials
Digital Learning Network events
Field trips to NASA Dryden
JPL Rover and other projects
Reduced Gravity Flight Opportunity
Space station uplink
Astronomy night
Math and science night
Kennedy, Dryden, Ames, Huntsville in-services
Flight days
LEGO FIRST robotics
FMA live
Career day
eMission™
"Name a Plane"

Table 5. Math Achievement Scores for G145

Grade	Test Yr	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	61	28	10	0
6	2004	61	28	10	1
6	2005	59	29	11	1
6	2006	50	29	16	5
7	2003	56	32	11	0
7	2004	64	27	9	0
7	2005	48	32	16	3
7	2006	52	33	14	1
8	2003	59	31	9	0
8	2004	52	38	9	1
8	2005	54	35	10	1
8	2006	38	34	22	6

Table 6. Language Arts Achievement Scores for G145

Grade	Test Yr	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	39	39	19	3
6	2004	39	41	16	5
6	2005	41	39	15	5
6	2006	41	31	20	6
7	2003	47	36	13	4
7	2004	46	37	15	3
7	2005	30	38	28	4
7	2006	38	36	21	6
8	2003	43	40	14	3
8	2004	39	37	19	6
8	2005	35	42	19	4
8	2006	27	39	26	8

Table 7. Comparison of NES G145 and 2003 Cohort Teachers on TLC surveys

	G145		2003 Cohort	
	M	SD	M	SD
Constructivist Teaching Philosophy (CTP)	3.17	0.09	3.29	0.4
Constructivist Teaching Strategies (CTS)	2.65	0.63	2.73	0.6
Constructivist Uses of Technology (CUT)	1.93	0.81	2.73	0.56
Technical Skills (TS)	2.83	0.27	2.99	0.49
Attitudes Toward Technology (ATT)	2.83	0.36	2.17	0.75

NASA Explorer Schools Case Study Profile: G145
2003 Cohort—Southern California Public Middle School: Grade 6-8

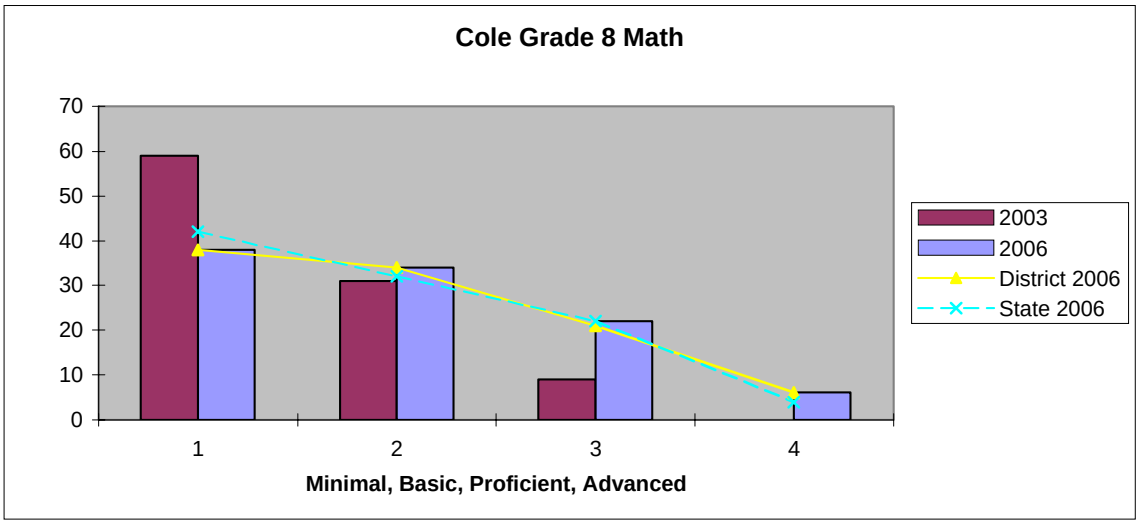

Figure 1. Comparison of G145 math achievement scores with district averages.

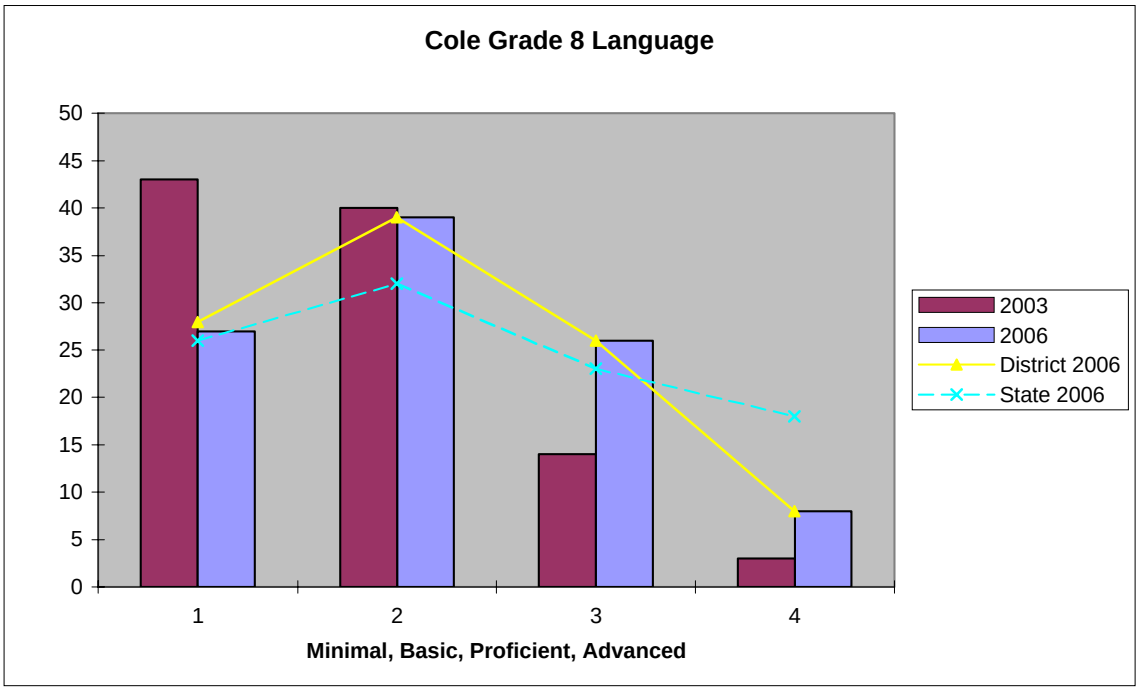

Figure 2. G145 language arts scores compared with district averages.

NASA Explorer Schools Case Study Profile: H99
2003 Cohort—Mid-size City, Massachusetts Public Middle School: Grades 6-8

Summary Comments Regarding NES H99
This NASA Explorer School is one of four middle schools in a mid-sized Massachusetts city. NES H99 had 604 students during 2004-2005 and about 510 in the 2005-2006 school year. In 2003-2004 about 63 percent of students were eligible to receive a free or reduced lunch based on their family income status. In 2004-2005 the percentage of students eligible for Title I assistance increased to 75 percent. In 2005, 35 percent of students came from homes where English is not the first language. (See Table 1 for more details.)

In 1999 NES H99 was the focus of a Massachusetts panel review because the school did not show significant improvement in achieving its annual progress goals. One of the recommendations from the 1999 state panel review is also a relevant recommendation for the H99 implementation of the NES project. The report recommended that "several initiatives in the improvement plan have action plans that list implementation strategies, expected short- and long-term results, standards for success, benchmark assessments, timelines, personnel responsible, and resources needed…a key ingredient to sound improvement planning [is] the use of data at the school, district, and city levels"[1]. NES also encourages its partnership schools to follow these procedures so that progress can be reviewed in the context of school-based data.

In the 1999 state review the school climate at H99 was considered "a significant impediment to improving student performance…. Unless the H99 leadership and staff address this issue, they will not improve student performance" (MA DOE, 2000). A follow-up review was conducted in May 2003 to analyze the data and written information regarding the school performance and improvement efforts. The review cited three factors as influencing the slow rate of improvement at H99: (1) high staff turnover, (2) incremental adoption of the Connected Mathematics education program, and (3) insufficient oversight of instructional strategies. It is worth noting that while H99 experienced an exceptionally high staff turnover between 2001 and 2003, the NES team at H99 remained constant with only one team member leaving, having taken a position outside teaching.

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[1] Massachusetts Department of Education. (June 12, 2000). *School panel review report, [School H99–Southeastern Massachusetts] public schools.*

Several practices initiated at H99 in response to the state department of education recommendations for improvement helped put in place some schoolwide practices that were compatible with and well suited to the implementation of the NES project. One of these was the monthly curriculum meetings between middle school math teachers and the district curriculum director. After two years of incorporating this practice, teachers reported these cluster meetings "to be useful means for tracking pacing of the Connected Math program curriculum and for sharing teaching ideas and strategies"[2]. The NES team at H99 applied this model to establish monthly science planning meetings.

A second school improvement noted by the school review panel that paved the way for NES is "the focused attention to specific school needs in the professional development offered to staff members…. To serve the school's need for focused professional intervention, the district provides at least one early release day per month along with four full-day opportunities throughout the year" (May 27-29, 2003). With this policy and practice already in place at the school, the educators at H99 were prepared to take advantage of NES science, technology, and mathematics professional development training and resource offerings. Table 3 (at the end of this document) provides a list of professional development workshops H99 faculty attended and hosted on site.

In the 2001 and 2003 panel reviews H99 teachers were advised to focus less on external factors for low student achievement and to instead look more closely at what instructional strategies are most successful in achieving the student learning goals established for the school. In the 2005 interview with H99 teachers, they expressed concern that they were expected to transform the low expectations and skeptical attitudes prevalent among students and their families. The teachers explained that most of "their students are from low socioeconomic backgrounds, and sometimes they equate that with not being able to determine their own future"[3] (Feb. 7, 2005, p. 2). However, by the end of the third year of the program, the H99 team expressed more optimism about what they can achieve with their students. The team lead reported that some students had been affected by the Explorer Schools project: "Being a NASA Explorer School has helped us…lift the morale of the school and made the students...believe they could achieve and maybe go on to a career in NASA" (May 6, 2006, p. 2).

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[2] NASA Explorer School H99 team interview conducted by CET evaluators via telephone call to school, May 6, 2006.
[3] NASA Explorer School H99 team interview conducted by CET evaluators via telephone call to school, Feb. 7, 2005.

The 2003 panel review identified communications problems both within the school and between the school and parents that hindered successful implementation of the school improvement plan. The discussion of H99's initiatives to address the NES family involvement goals (Outcome 3) provides some parental comments that suggest that school climate issues are still a concern at H99. However, this school has planned and organized a comprehensive strategy to address family and community involvement, and it may take more than two years for the prior stigmas to be changed.

The case study data shows that H99 NES team members have initiated a coherent, focused effort to have a positive impact on science, technology, and math education and on student perceptions of their future. The NES H99 case study focuses on the science, technology, engineering, and mathematics interventions at H99 to find out how the NES project was implemented at this school and its impact schoolwide on educators and students and their families. Descriptions of how well NES H99 achieved the six NES anticipated outcomes are presented in context later, but here are examples of some of the successes that H99 achieved as a NASA Explorer School.

- The school NES planning team has expanded to 10 members, four of whom were members of the original NES application group. This group meets monthly to plan and carry out STEM-G-related professional development, curriculum integration, and community (family) events.
- H99 established a NASA Cadet program and local steering committee with the community college that H99 student cadets attend for career-related enrichment activities and that supplies speakers to H99.
- The team at H99 has worked closely with the NASA aerospace education specialist (AES) and field center staff to make their curriculum more inquiry based and hands on. These curriculum changes included strategies for sustainability, schoolwide teacher training, increased block scheduling for science and technology curriculum, and access to NASA opportunities for as many students as possible.
- Tables 5 and 6 and Figures 1 and 2 illustrate the improvements in reading, language arts, and mathematics that H99 has experienced during its three-year partnership with NASA. While H99 students have not matched state achievement scores, they have exceeded district averages in math for seventh and eighth grades in 2006.

In 2003 the review team praised H99 educators for providing a new set of learning objectives that can be easily tracked by examining student work samples throughout the year "rather than relying on the belated results of standardized assessments to monitor progress"[4]. The 2003-2004 School Improvement Plan identified gaps in student learning based on a careful and thorough analysis of student test results and oriented the plan around teaching and learning targets. However, a weakness identified in the H99 plan is that there are no systems in place to monitor whether the defined teaching and learning strategies are being implemented. In addition, there is no plan for tracking to what degree the teachers using the defined instructional strategies are meeting the objectives identified.

The lack of a system for documenting teaching strategies used and how they tie to learning objectives is also a weakness in the H99 implementation of the NES project. When asked in the 2006 interview how the school was evaluating the impact of its strategic and implementation plans, one teacher responded, "No, we did not put any measures in place. We were told at [field center orientation] that student interest surveys would be administered, and we expected the evaluation to come through NASA. I kept a binder documenting everything we have done. I kept attendance sheets, teacher comments about workshops, and documented all of the media coverage" (May 6, 2006, p. 4).

We hope this case study analysis will suggest ways that NASA field center staff can help teachers identify ways to capture data that documents student performance outcomes resulting from specific instructional interventions and content resources associated with NES intervention at the school level.

Outcome 1: Increased participation and professional growth of educators in science.

The NES H99 team formed in 2003 with five members. They identified key academic needs and wrote their strategic plan after returning from the orientation training. (See Table 2 for the summary of academic needs.) They expanded the team to include two other science teachers who did not attend the orientation training. The team meets once a month. Members indicate that they organize each meeting with an agenda that includes details pertaining to specific

[4] Massachusetts Department of Education. (May 27-29, 2003). *Report of two-year follow-up review [School H99- Southeastern Massachusetts] public schools*, p. 20.

events and activities. Currently the team has nine people (eight science teachers and a social studies teacher).

The NES H99 team reports that it has increased its use of inquiry-based teaching and learning strategies and has developed an expanded repertoire of NASA curriculum materials. Table 3 provides a list of the professional development opportunities in which the H99 school has sent teacher representatives. Table 4 lists NASA (and NASA-affiliated) resources that H99 teachers have incorporated into their school curriculum. The NASA field center staff coordinating support for NES H99 identified this school as doing a superior job in implementing the program with the school's success in involving non-NES team educators, obtaining administrator support, and obtaining community involvement and local partnerships. Field center staff also cite H99's success in developing plans for implementing technology into teaching and using wider applications of technology, such as the sounding rockets and scientific use of balloons for student research.

NES H99 team members describe how the NES program has benefited them on a personal and professional level. One person, who is also a school administrator, said, "I am at the end of my teaching career, (now serving) as administrator. NES has just been really uplifting…to be able to see the types of things we are able to offer to the students. It's really kept me interested and motivated in the job. It's been a boost. For science teachers NES has been a dream come true, in which they get to meet scientists who are just like them except they get things into outer space. [I am] proud to say I am a NASA educator. It also has been an uplifting experience and a privilege to work with NASA scientists and the team."

The following are examples of professional growth, challenges faced, and achievements made at H99 in terms of the professional growth guidelines presented in Brief 5 (Ruberg & Martin, 2007).

Guideline 1. Content. Participants are immersed in models of instruction that address these four aspects of science proficiency: (a) know, use, and interpret scientific explanations of the natural world; (b) generate and evaluate scientific evidence and explanations; (c) understand the nature and development of scientific knowledge; and (d) participate productively in scientific practices and discourse.

- The NES team attended a variety of workshops to learn about STEM-G-related topics. The workshops included the History of Winter training in Lake

Placid, NY, and a simulation activity on how to design a rover vehicle that can be launched to Mars.

- The NES team received extensive support from AES in developing hands-on activities and integrating inquiry-based learning into their curriculum. The team lead takes the responsibility to make sure "everyone in my building has everything they need. In my science classes we are tracking solar storms, doing Radio Jove, and we have friends in Alaska. I've done SUBSIM rocket and balloon experiments. My classes are involved with e-Missions™. My eighth grade NASA students facilitate NASA family night" (May 6, 2006, p. 3).
- The NES team hosted professional development training on NASA's Mission Geography for non-NES teachers, including science and social studies teachers. The NES team also offered training on Mission Geography and EarthKam at the district level. One of the Goddard AES did a two-hour training for teachers using EarthKam.

An H99 team member reported that "the AES at first talked way over our kids' heads. They altered what they were doing, and over the years we've seen a change in [how] the AES have worked at our school. Now it is more inquiry based and hands on" (May 6, 2006, p. 3).

Guideline 2. Coherence. The professional development is intensive and sustained.

- AES and field center staff have been extremely helpful. They received extensive AES support on developing a schedule. Field center staff facilitated distance learning events and arranged in-school programming. For the distance learning events people from the field center deliver a presentation, but often they don't offer activities to go with the presentation. It's just talking.
- The NES team has collaborated with non-NASA people, such as local science professionals.

The quote provided in response to Guideline 1 shows that changes, adjustments, and communications between the school science team and the AES have been fruitful and progressive. By year three both the school and the field center staff have grown increasingly skilled in working together. If the communications and collaborations continue, the program will continue to grow. At this point the changes in infrastructure at the school (described below) support sustainability

of the new teaching strategies and an ongoing relationship with NASA science education opportunities.

Guideline 3. Active learning. The professional development engages teachers in concrete teaching tasks that are based on the teachers' experiences with students.

- Here are some examples of how the NES team uses e-Missions™ and Radio Jove.
  - "The e-Mission (we pilot tested) involves math and computation. It provided a great deal of opportunities for the students to reach beyond their capability. It was embedded in a very interesting e-Mission, going to the moon and finding a site on the moon where could set up a base. Kids did it no questions asked."
  - "We set up an experiment that went into the upper atmosphere to see the effects on a CD. We have Radio Jove antennas on the roof. We focus on that in the eighth grades, though there are other students from other grades in that. With Radio Jove we listen to the sun. We use that in conjunction with sun spotters. We are tracking solar weather. We take sun spotters, follow the sun spots, listen to the sun, and try to predict which of these spots will have an impact on Earth. We put the data in, and we're able to see data from other schools across the country."
- "In the science class we track solar storms, doing Radio Jove, SUBSIM rocket, and balloon experiments. The Radio Jove after-school club kids pitch in with NASA family night, and they helped do the patch/downlink for that event."
- At least two students have gone to the science symposium every year where they report on their research.
- One teacher at H99 said, "We've all expanded our repertoire curriculum materials from the NASA resources that we've been exposed to. We have many more things we can use in working with the students" (Feb. 7, 2005, p. 11).

Guideline 4. Content. Professional development focuses on subject matter knowledge and deepens teachers' content skills.

- NES H99 focused on "giving students opportunities around math, science, and technology" both in the classroom, integrating NASA resources such as e-Missions, and through after-school projects, such as Radio Jove, which was used with tracking solar flares.

- By embedding science and math activities in e-Missions, "students who would normally balk at doing the math…did it and felt good about themselves" because it was embedded in a mission to the moon.

Guideline 5. Active learning. The professional development is grounded in a common set of standards and must show teachers how to connect their work to specific standards for student performance.

- The NES H99 science, technology, and math education interventions would be strengthened if they were tied to a set of evaluation goals and specific standards for student learning. Right now according to the NES teachers interviewed, the school does not conduct formal evaluation activities. The only measures they collect are student attendance, teacher comments about workshops, and documentation of media coverage.

Guideline 6. Coherence. Reform strategies are connected to other aspects of school improvements.

Some of the schoolwide improvement strategies try to address changing student attitudes about themselves and their potential. Here are some teacher thoughts about student self-efficacy issues and how the teachers try to address them in the context of NES initiatives and opportunities.

- "We keep [the NES project] reaching for the stars with students. Also we work to bring [the] rest of the school to [the] same level of excitement that we have. Low SES students don't see what they can do in their future. This program gives them the ideas that they can and will accomplish greater things" (Feb. 7, 2005, p. 2).
- "Expose students to NASA. Make them believe they could achieve and maybe go into a career in NASA. Being a NASA Explorer School has helped us achieve those expectations. It has lifted morale of the school and made the students feel special" (May 24, 2006, p. 2).

NES H99 has incorporated strategies that will sustain the science, technology, and math education reform stimulated by the NES project. Here are some examples of these schoolwide changes:

- The school day was modified to be able to integrate more NASA opportunities schoolwide. "This year we went from 6 to 10 blocks of science. One block is dedicated to technology; another block is dedicated to NASA" (May 6, 2006).

- The school NES planning team has expanded to have 10 members, 4 of whom were members of the original NES application group. In addition to the core startup team, there are nine science teachers, the math/science curriculum director, assistant principal, and one social studies teacher. Local funding has provided support so that the expanded team members also receive stipends.

In addition to our analyses from the NES case study, we report some key findings from the survey data on H99. These data would shed light on the results of case study analyses and serve as data triangulation with our case study findings. Consistency or inconsistency will be discussed in the following section.

We were able to pair three teachers at H99 and compare them with the rest of NES 2003 cohort teachers. Table 7 illustrates H99's mean and standard deviation on TLC surveys compared with the NES 2003 cohort.

Table 7 shows H99 teachers had lower perceptions of constructivist uses of technology and technical skills than other NES teachers. However, they showed more positive attitudes toward technology than other NES teachers. One reason for the attitude changes might be their participation in various professional development workshops. Likewise, teachers were seeing their students get excited when immersing in the technology-enhanced learning contexts such as e-Missions and Radio Jove. The high satisfaction on the effects of the NES program on student interest and participation of STEM-G was also evidenced by the team lead survey.

The TLC findings on H99 were consistent with our case study analyses of how teachers responded to the use of technology in their classroom. In the interview teachers showed excitement of their own teaching and saw the impact of using technology on their students. The reaction from their students has changed the way how H99 teachers view the use of technology in learning as well as in teaching.

In the team lead survey the H99 team lead reported not being at all satisfied with the participation of the whole school faculty, but extremely satisfied with the involvement of the administrator team member. This finding is consistent with our case study finding that one of the successful accomplishments of H99 is the support of the school administrator.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.

The NES H99 team purchased the following technologies with NES funding:

- Videoconferencing equipment
- Telescope
- Projector
- Video camera
- Digital camera
- Flex scan microscopes (particularly for eighth grade)
- 3-D models of the solar system

One of the challenges that H99 team members mentioned was planning their in-school and after-school programs based on the technologies that they planned to purchase with the NES funding. In 2004 the funding did not arrive until March, and in 2005 the funding had still not arrived by February. One of the H99 teachers commented that there "is a challenge of trying to do these programs when you don't have the money to purchase the equipment" (Feb. 7, 2005).

By their third year as a NASA Explorer School, H99 was integrating many different kinds of technologies into the their science and technology instruction. In the spring 2006 survey the field center staff noted that H99 excelled in its plans for implementing technology for wider applications. Their use of technology to support their NES interventions was evident in the professional development workshops that they completed, listed in Table 3, and the list of NASA resources they used, shown in Table 4, and described in the school's fulfillment of guidelines 3 and 4 in the preceding section.

Outcome 3. Increased family involvement in children's learning.
As mentioned in the introduction, improving communications with parents and the community outside the school is one of the recommendations given to NES H99 from its 2003 department of education review panel. The H99 initiative to increase family involvement in science, technology, engineering, and mathematics topics as a NASA Explorer School was well suited for H99's overall school improvement program. The NES team initiated family fun night and invited grade six families, parents, and students.

So far, the NES team has planned three family science nights. The first was an induction night where they recognized the sixth grade cadets (students who were selected to be part of the academy). In 2006 the "Radio Jove after-school club kids pitched in with NASA family night, and they helped do the patch for the downlink for that event" (May 6, 2006).

In 2005 the NES team invited grade six families and students for a family night in which all activities focused around the moon. The grade eight cadets facilitated the information stations. This year, the seventh grade family night will focus on Mars and will use the Mars Bound materials on which the H99 teachers were trained at NSTA.

Searching for postings about H99 outreach and family events on the web, we found the following comments from parents of H99 students that suggest that school climate and behavior issues are still a concern. Unfortunately, it is more likely that parents who have had a negative experience will post a message. However, these comments help us identify the kinds of concerns parents have had about the school during the NES project—even though these comments do not directly pertain to NES or STEM-G education issues.

> "I am shocked to learn that this school is doing so badly. I know they are underperforming, but I had no idea it was so bad. My child graduated from elementary school an honor student, went to this school, and is doing so badly. I'm convinced it has a lot to do with their teaching style. Luckily she had her start in Boston" (April, 2006).
>
> "This school is a mess. There have been so many changes in the administration that it's hard to keep track. There is no punishment for the bad kids—they get away with everything. My kid is afraid to go there half the time because there is so much crazy stuff going on in the halls and in

> the classes. The kids are out of control. The teachers (some of them) try hard, but most of the time there are subs instead of teachers. They just put in a new principal and fired others. School starts in a few weeks, and it's *gonna* be crazy again" (August, 2005)
>
> "I not only find this school lacking in performance and discipline, I also include the school district. The school is just getting out of hand. Some teachers DO NOT want to teach the way they should, children do not face disciplinary actions at home when in trouble with school. How can we let our schools go to such garbage? This is the worst system and school I've had to deal with. It's time for a MAJOR overhaul with faculty, staff, and anyone else who doesn't want to be there" (April, 2005).
>
> "My daughter goes to this school, and it is awful. The school smells bad, the kids always fail MCAS. The school is just dirty. The kids are 'learning in poverty' " (February, 2005).

Outcome 4. Increased student interest and participation in STEM-G.
NES gives students the idea that they can and will do more things than they thought they were capable of. The program changes their self-perception of where they fit into society. Students also enjoy piloting e-Missions, even the special education students. The entire school's science curriculum incorporates NASA.

Students in the special education program have been able to participate in this program using their specific gifts. Many of them are very adept at computers. One of the boys did all of the computer technology for the Wallops rocket launch, and he is doing very well in high school. This is a boy whom we almost lost.

Every student and teacher viewed the [International Space Station] downlink. The students were impressed, and the teachers were excited.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teachers observation are provided after each strand.

Participate productively in STEM-G practices and discourse.

> "While doing a pilot e-Mission, students are learning mathematical computation as well as science. Students are immersed in a very interesting e-Mission that involves going to the moon and finding a site on the moon where they get to set up a base. Students completed the tasks without any questions" (Feb. 7, 2005).

Perceive stronger self-concept.

> "Most of the students are from low socioeconomic backgrounds, and they sometimes equate that with not being able to be successful in their own future. NES gives students the idea that they can and will do more things than they thought they were capable of doing, which changes their self-perception of where they fit in society. Kids feel special and are more confident about what they can actually accomplish" (Feb. 7, 2005).

Change attitudes about learning.

> "After every student and teacher viewed the downlink, the students were impressed with the downlink and were excited about it" (May 6, 2006).

Actively participate in hands-on and authentic scientific research.

> "Students conducted an experiment that went up into the upper atmosphere to see the effects on a CD. Students tracked solar weather, took sun spotters, followed the sun spots, listened to the sun, and tried to predict which of these spots would have an impact on Earth. They put the data into the computer and saw data from other schools across the country" (Feb. 7, 2005).

Outcome 5. Increased student knowledge about careers in STEM-G.
The school now has students who have expressed interest in pursuing careers with NASA when they enter the workforce. One of the teachers said, "Our cadets in the eighth grade are very motivated. They feel special…[they] have done more than [they] ever thought [they] could… . Hopefully this will carry over to high school and college" (May 6, 2006).

The student interest is also expressed in how many of the students want to join the NES H99 NASA Cadets program. "We have more kids now decide that they would like to become NASA cadets when they see the types of things they are doing" (Feb. 7, 2005).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.
Using multiple regression analysis of student responses on the student interest assessment, we have found that there is a relationship between what NASA materials teachers use in the classroom and students liking that subject. While this trend is reported across the population of respondents, it is also consistent among the H99 students who completed the NES student interest survey. For example, teachers used NASA materials in the science class, and students showed liking science more. Analysis shows that students who have used NASA materials also report that they think they will do well in science this year. The use of e-Missions and Radio Jove has affected how well students think they can use computers with science data, use math to explore solutions to problems, and present the results of an investigation or project to the class. There is also a relationship between how well they think they are using math and how much students like math.

The following strands are indicators of increased student ability to apply STEM-G concepts and skills in meaningful ways. Examples from teacher observation are provided after each strand.

Understand and use scientific explanations of the natural world in context of a problem-solving activity.

> "In the pilot e-Mission, students who were more capable of using math at a higher level would help their peers and bring them up" (Feb. 7, 2005).

Understand how to use and interpret the data obtained from technology tools to support STEM-G-related inquiry activities.

> "The kids in the special program had found ways to be part of this program with their specific gift. Many of them are very adept at computers. One of the boys did all the computer technology for the Wallops rocket launch, and he is doing very well in high school. This is a boy whom we almost lost" (Feb. 7, 2005).

Evidence is available to demonstrate student performance increased in STEM-G and related subjects like language arts.

NASA Explorer Schools Case Study Profile: H99
2003 Cohort—Mid-size City, Massachusetts Public Middle School—Grades 6-8

As one of the case study schools, H99 was asked to take the student interest survey in spring 2006. The grades 4-6 version of the survey had 11 participants, and 19 completed the grades 7-9 questionnaire. H99 students had mean scores at least one standard deviation above the overall item mean scores in the following items:

- "Tell us how much you like…" English, math, geography, science, and social studies/history.
- "Rate how much you know about…" English, language arts, geography.
- "How well do you think you will do in science this year?"
- "How well do you think you will do in math this year?'
- "Rate how good you are at…" using computers with science data, using math to explore solutions to problems, presenting the results of an investigation or project to the class.
- "How often do you or your teachers use NASA materials in…" science, technology education.
- "Tell us how often you think you will use math as an adult…" in my job or career.

Clustering the questions demonstrated a relationship between student observation of NASA materials used in the classroom and students' liking that subject. For example, in cases where teachers used NASA materials in their science class, students indicated a higher interest in science. In these cases students also indicated a higher level of confidence in how well they will do in science this year.

In the case of NES H99, the use of NASA activities is associated with students showing a higher level of confidence in how good they are at using computers with science data, using math to explore solutions to problems, and presenting the results of an investigation or project to the class. In these areas the H99 student responses were well above the average school ratings.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	647	626	604	510
Black, non-Hispanic	55	61	71	63
Asian	34	23	16	15
Hispanic	69	70	76	67
Indian, Alaskan Native	2	3	2	0
White, non-Hispanic	487	469	439	360
School location (rural, suburban, urban, mid-size central city)	mid-size central city	mid-size central city	mid-size central city	mid-size central city
School type (public, private, charter, magnet)	public	public	public	public
Title 1 status (yes or no)	yes	yes	yes	yes
English language learners				
Special education students		``		100
Free and reduced price lunch		63.26%	75.17%	
Teacher population		44	56	61

Source: CCD Public school data for each school year, National Center for Education Statistics, Institute of Education Sciences.

Table 2. Summary of Academic Needs Identified by H99 in 2003

1	Problem Solving: Solve problems that arise in mathematics and in other contexts
2	Problem Solving: Apply and adapt a variety of appropriate strategies to solve problems
3	Life Science: Reproduction and heredity
4	Physical Science: Properties and changes of properties in matter
5	Physical Science: Transfer of energy
6	Earth and Space Science: Structure of the Earth system
7	Communication: Communicate their mathematical thinking coherently to peers, teachers, and others
8	The Nature of Technology: Students will develop an understanding of the core concepts of technology
9	The World in Spatial Terms: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information
10	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
11	Earth and Space Science: Earth in the solar system

Table 3. NASA Professional Development Opportunities That H99 Teachers Completed

NSTA (national conference)
Orientation workshop
Sustainability workshop
History of Winter
Student symposium (at KSC)
Content workshop: Low atmosphere rockets and balloons
On-site, districtwide training on EarthKam
Monthly DLN training

Table 4. NASA (and NASA-affiliated) Resources Used

LEGO Robotics (after school)
Radio Jove—tracking solar flares (after school)
Balloon experiments
GLOBE environmental project (after school)
e-Missions
Challenge question of the day
Mission Geography (grade 6 science and social studies)
After-school video club
Rocket launch at Wallops Island with student experiment on board
Balloon launch from school with experiment as payload
NASA web site on the study of astronomy for grade

Table 5. NES H99 Math Achievement Scores

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	65	27	7	1
8		64	28	7	1
6	2004	70	25	4	1
8		53	39	8	0
6	2005	55	34	8	3
8		57	34	8	1
6	2006	61	27	11	1
7		42	44	9	5
8		54	35	7	4

Table 6. NES H99 Language Achievement Scores

Grade	Year	Min. Lang.	Basic Lang.	Prof. Lang.	Adv. Lang.
7	2003	21	49	31	0
7	2004	26	51	24	0
7	2005	13	54	33	0
6	2006	25	48	27	0
7		13	51	32	3
8		8	36	54	2

Table 7. Comparison of NES H99 and 2003 Cohort Teachers

	H99		2003 Cohort	
	M	SD	M	SD
Constructivist Teaching Philosophy (CTP)	3.49	0.28	3.29	0.4
Constructivist Teaching Strategies (CTS)	3.36	0.17	2.73	0.6
Constructivist Uses of Technology (CUT)	1.98	0.51	2.73	0.56
Technical Skills (TS)	2.32	0.24	2.99	0.49
Attitudes Toward Technology (ATT)	2.71	0.56	2.17	0.75

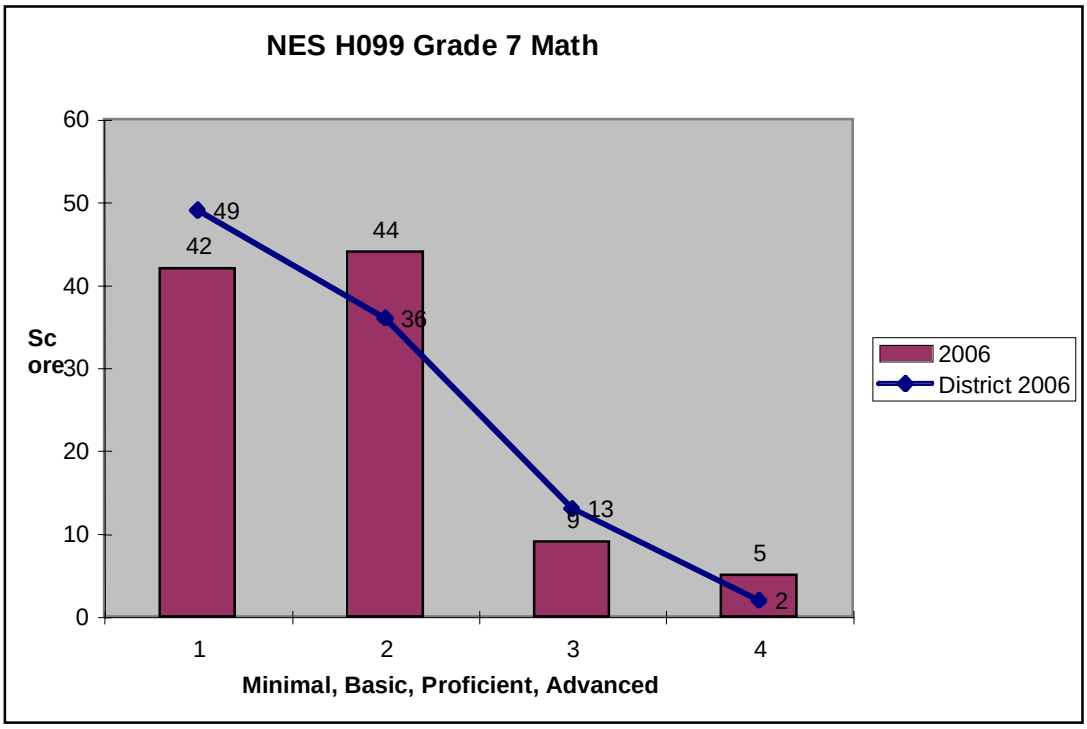

Figure 1. How NES H99 seventh grade 2006 math scores compare with district averages. This bar graph illustrates how H99 has matched and to some extent exceeded district averages. The greatest improvements are in the decrease in the percentage of students scoring at the minimum level and the increase in student scoring at the advanced level.

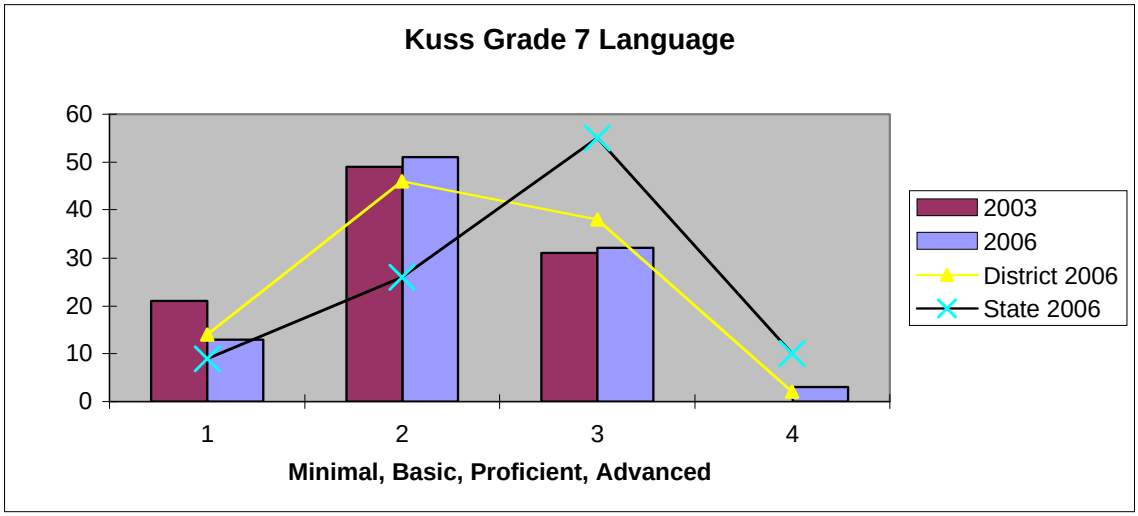

Figure 2. The H99 2003 and 2006 seventh grade language arts achievement scores compared with district and state averages for 2006. The comparison shows that H99 has

improved to closely match district scores and with continued improvement could eventually match state averages.

NASA Explorer Schools Case Study Profile: I59
2003 Cohort—Small Town, Tennessee Public Elementary School: Grades PK-5

Summary Comments Regarding I59
The NES I59 elementary school is located in a town of about 5,000 in Western Tennessee. I59 joined the NASA Explorer Schools program in 2003. Enrollment averages between 915 to about 930 students. The student population is approximately 69 percent African-American and 30 percent white. It qualifies as a Title 1 school. About 24 percent of the students receive special education services. (See Table 1 for additional details.)

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Here are some of the accomplishments achieved by I59 in its three years as a NASA Explorer School:

- Two years ago I59 was on the list of poor performing schools. It is no longer on that list. Student reading and math achievement scores have improved significantly, as can be seen in Tables 4-7 and in Figures 1 and 2.
- The educators at I59 have teamed up with faculty at a local university to plan sustainability initiatives to maintain the improvement trend.
- The school applied for and received another grant that supports professional development and technology purchases on a countywide basis.

One of the challenges that I59 educators face is making sure the improvements they have made for their students are supported in a coherent fashion as students proceed to middle and high school. At this time the middle school to which students from I59 matriculate is on the state list for needing improvement.

Outcome 1: Increased participation and professional growth of educators in science.
The I59 team consists of three teachers and an administrator. The team lead was the same from 2003 to 2005. Two additional teachers, who teach reading and social studies, respectively, came on board after the program had started.

In 2000 the team lead participated in a NASA educator workshop, where she learned about opportunity to become a NASA Explorer School. I59 has sent teacher representatives to content workshops, including Math Magic, Signals of Spring, and Web Watchers as documented in Table 3. The opportunity to attend various workshops has been very valuable in terms of teacher growth in content

knowledge and new perspectives on teaching and has supported improving content knowledge that the team identified as academic needs (see Table 2). The NES team members said that they are now more aware of NASA careers and what it takes for their students to have a science career.

I59 team members perceive that being a NASA educator has opened up many other opportunities for themselves and their students. Since becoming an NES school, "We have applied for and received another grant that includes technology and math professional development for the whole county. NES has opened doors and possibilities for us to seek external help" (Jan. 20, 2005). Besides seeking external help, the I59 team collaborates with a local university on a sustainability grant and has developed a committee that supports school activities.

The I59 team has initiated several schoolwide STEM-G-related initiatives. The team lead reported:

> "We are trying to get the lower grade students to sign up and do more with upper grade students so that lower grade students can get ready for the field trip in the future. Now we have fifth grade classes partner with second grade classes about every other week. But the impact of this is minimal" (Jan. 20, 2005).

I59 team members described the types of resources they have incorporated into their curriculum or as schoolwide activities. (See Table 4 for details.)

> "It is a tomato seed project in that I have my students observe growing tomato seeds in a simulated, monitored environment. Students took pictures and reported their results over the computer" (Jan. 20, 2005).

> "It was NASA resources on nine planets and the percentage of gases in each planet to introduce students to fractions, percentages, and gases in the atmosphere of each planet" (Jan. 20, 2005).

> "In the classroom where students were testing NASA equipment on their core catalogue that they will eventually put in that to see how well it actually works with the kids. Kids were excited with working on the NASA equipment and reporting back to NASA" (Jan. 20, 2005).

I59 team members also find that NASA online resources are valuable for lesson plans, activities, and content knowledge that the teachers need to teach their students.

> "I can find activities from the web site that fit into almost any unit of a lesson" (Jan. 20, 2005).

In spite of the effortless implementation of the NES project, a team member stressed the amount of time and attention the teachers must devote to standardized testing:

> "The school was on the list of poor performing schools two years ago, and there has been a huge emphasis on improving scores. I have to make sure that whatever I do that is NASA related is also going to support improving scores. Sometimes the NASA program is pushed aside because of the tests" (Jan. 20, 2005).

The low reading scores also have required a lot of attention in the curriculum." If the kids can read better, they would probably do better on their science tests" (Jan. 20, 2005). The need to increase students' reading scores pushes science aside at times.

In addition to our analyses from the case study, we report some key findings from the survey data on I59. This case study analysis includes data from the teachers; Teaching, Learning, and Computing (TLC) survey; and the team lead survey to identify consistencies or inconsistencies with our case study findings. Because we were able to pair only one teacher from I59, we did not have sufficient information to discuss the findings from the TLC survey.

In the team lead survey the team lead said that because of NES, the school has all of NASA's resources at its disposal. Teachers can do more for the students and get them interested in pursuing math and science. More and more teachers are striving to change things at the school. As a matter of fact, its experiences with NES have helped the school apply for another grant that supports professional development and technology purchases on a countywide basis.

The team lead rated only "somewhat satisfied" with the participation of the whole school faculty, while rating "very satisfied" with the involvement of the administrator team member. This evidence further adds to the case study findings that having an administrator on the team is instrumental to the implementation process and encourages other teachers to be more involved in STEM-G activities.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
The I59 team purchased the following technologies with NES funding:

- Videoconferencing equipment
- Computers
- Printers
- Calculators
- Scanners
- Vandegraff generators
- Copiers
- Rockets

In terms of technology support, NASA has provided I59 with what it needs to successfully implement what it wants to achieve. However, there were still some technical problems with videoconferencing when the school needed it for a career day with the field center.

Outcome 3. Increased family involvement in children's learning.
The I59 team initiated several after-school programs for students and parents, such as the science club and family science nights. Several enrichment programs, including career days and tutoring programs, are also provided through the school. Striving to improve parental involvement has shown positive outcomes in terms of number of parents who come into the school. "The number of parents who participated in the family science night has increased from 300 to 600 people" (Jan. 20, 2005). Because of NES parents are more aware of it and realize its importance to the school and community. "Parents used to not care about what's happening on TV with NASA, but now they stop what they are doing and take a look at it" (Jan. 20, 2005).

Searching for postings about I59 outreach and family events on the Internet, we found the following comments from parents of I59 students. In 2004 a parent gave credit to the teachers who have helped the person's child to learn more advanced knowledge. Although no direct link can be drawn between this parent's comment and the NES project, we can draw a close relationship with what the NES I59 teachers have done to try to get all of the school teachers and students to become involved in STEM-G activities.

> "I am very thankful for (this school). I have a son in the fifth grade. The teachers are wonderful, and they do care about our children's education. The students are learning many more things at a higher level. They are getting prepared for harder things to come. My daughter will be starting kindergarten next year. I am very excited for her" (October, 2004).

Outcome 4. Increased student interest and participation in STEM-G.
The I59 team has implemented several STEM-G-related activities to promote students' understanding, such as Magic Math, Simulated Environment, and Earth to Orbit Design Challenge. Team members have observed students' positive reaction to and interaction with the NASA equipment. Teachers said students care more about the types of activities they are doing and aware that they are associated with NASA. The excitement generates quickly when they realize they are participating in research that NASA would actually use, teachers said.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teachers' observations are provided after each strand.

Participate productively in STEM-G practices and discourse.

> "Students are excited about working with the NASA equipment and reporting the data back to NASA" (Jan. 20, 2005).

Show noticeable curiosity in STEM-G-related topics and events.

> "Kids now got excited about the things related to NASA because they know they are associated with it. They would come in and say they saw it on TV. They were excited when they knew they were participating in research that NASA would actually use" (Jan. 20, 2005).

Actively participate in hands-on and authentic scientific research.

> "The school science club has gone to the Space and Rocket Museum in Huntsville. The kids were enthusiastic about participating in NASA research" (Jan. 20, 2005).

Outcome 5. Increased student knowledge about careers in STEM-G.
NES provides opportunities for students to understand more about careers in STEM-G-related fields. For example, the school science club goes to the Space and Rocket Museum in Huntsville, AL, and meets with scientists and astronauts. I59 already had a science club before NES, but a lot of activities that the teachers are using now are coming from the professional development workshops.

> "One of the students told me that she knew what she wanted to do when she grew up on our way home from a field trip to the Space and Rocket Museum in Huntsville. This kid thought of the idea of actually being able

> to work on the International Space Station. This has never happened before" (Jan. 20, 2005).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.
We conducted multiple regression analysis of student responses on the student interest assessment. We found a positive correlation between the NASA materials teachers use in the classroom and how much students like the subject. In classes where teachers used NASA materials in science, students indicated that they liked science more.

The following strands are indicators of increased student ability to apply STEM-G concepts and skills in meaningful ways. Examples from teacher observation are provided after each strand.

Understand, use, interpret the nature and development of STEM-G topics

> "We had kids go to the student symposium in Florida and present things that they had done during the year" (Jan. 20, 2005).

Increase in achievement tests in math and language arts/reading.

> "We were on the list of poor performing students in Tennessee. But last year we came off the list because our scores went up." (Jan. 20, 2005)

As one of the case study schools, I59 was asked to take the student interest survey in spring 2006. I59 students had mean scores at least one standard deviation above the overall item mean scores in the following items:

- "How much you like…" geography, science, social studies and history.
- "Rate how good you are at…" using computers with science data, presenting the results of an investigation or project to the class.
- "How much would you like to have these jobs…?" Computer specialist, geologist, engineer.
- "How often do you or your teachers use NASA materials in…" Science, technology education.

Clustering the questions demonstrated a relationship between student observation of NASA materials used in the classroom and students' like of that subject. For example, in cases where teachers used NASA materials in their science class, students indicated a higher interest in science. In these cases students also indicated a higher level of confidence in how much they would like to have jobs as a computer specialist, geologist, and engineer.

In the case of NES I59, the use of NASA activities is associated with students' showing a higher level of confidence in how good they are at using computers with science data and presenting the results of an investigation or project to the class. In these areas I59 student responses were well above the average school ratings.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
All students	970	902	915	927
Black, non-Hispanic	664	679	626	639
Asian	1	3	2	5
Hispanic	6	6	13	14
Indian, Alaskan Native	0	0	0	2
White, non-Hispanic	299	286	274	267
School location (rural, suburban, small town, urban)	small town	small town	small town	
School type (public, private, charter, magnet)	public	public	public	
Title 1 status (yes or no)	yes	yes	yes	

Table 2. Summary of Academic Needs Identified by I59 in 2003

1	Problem Solving: Build new mathematical knowledge through problem solving
2	Problem Solving: Solve problems that arise in mathematics and in other contexts
3	Problem Solving: Apply and adapt a variety of appropriate strategies to solve problems
4	Algebra: Understand patterns, relations, and functions
5	Data Analysis and Probability: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
6	Physical Science: Motions and forces
7	Earth and Space Science: Earth's history
7	Earth and Space Science: Earth in the solar system
8	Measurement: Apply appropriate techniques, tools, and formulas to determine measurements
9	Design: Students will develop an understanding of the attributes of design
10	The World in Spatial Terms: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information

Table 3. NASA Professional Development Opportunities That I59 Teachers Completed

Magic math
Orientation workshop
Sustainability workshop
Signals of Spring
Student symposium
Web Watchers
On-site career day with Marshall

Table 4. NASA (and NASA-affiliated) Resources Used

Magic Math
Earth to Orbit Design Challenge
Simulated tomato seed environment
NASA web site on the study of astronomy
Career day with Marshall
Space and Rocket Museum in Huntsville

Table 5. NES I59 Math Achievement Scores Compared with State Average

	2005	2006	2006 State
Math	50 C	53 B	55 B
Reading/Language	47 C	50 C	53 B
Social studies	49 C	51 C	52 C
Science	47 C	51 C	52 C

Table 6. NES I59 Math Performance

Grade	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
5	2003		26	50	24
4	2004		19.6	57.3	23.1
5			17.6	68	14.4
4	2005		13	54.3	32.7
5			5.5	57.9	36.6

NASA Explorer Schools Case Study Profile: I59
2003 Cohort—Tennessee Public Elementary School: Grades PK-5

Table 7. NES I59 Reading Performance

Grade	Year	Min. Reading	Basic Reading	Prof. Reading	Adv. Reading
3	2004		15.2	56.3	28.5
4			15.4	55.2	29.4
5			20.1	61.7	18.2
3			12.4	49	38.6
4			17.9	47.5	34.6
5	2005		6.9	60.7	32.4

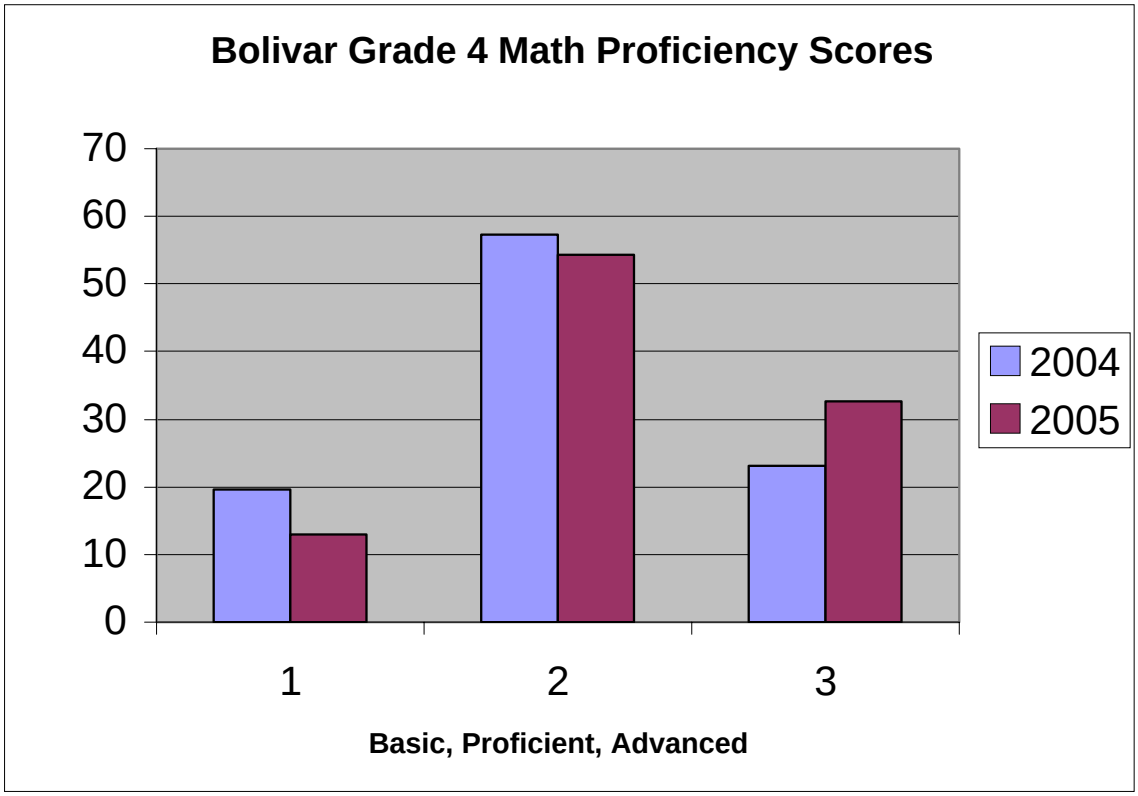

Figure 1. Comparison of I59 percentage of students within proficiency categories for 2004 and 2005.

NASA Explorer Schools Case Study Profile: I59
2003 Cohort—Tennessee Public Elementary School: Grades PK-5

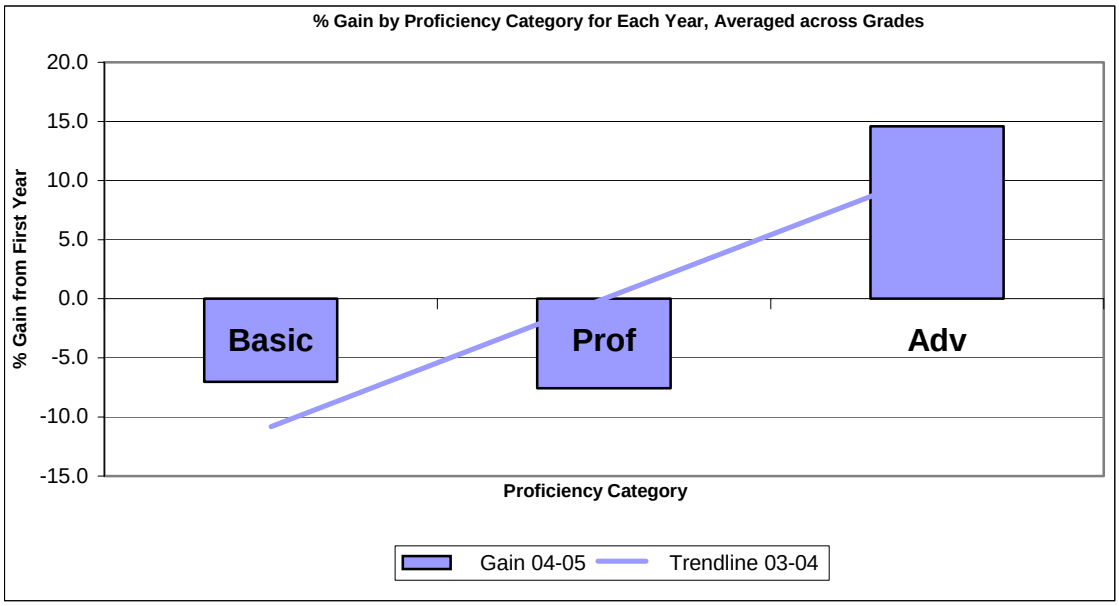

Figure 2. Comparison of I59 students' gain by proficiency category for 2003-2004 and 2004-2005

NASA Explorer Schools Case Study Profile: J71
2003 Cohort North Carolina Public Schools—Grades 6-10

Summary Comments Regarding J71
NES J71 consists of three schools. Two schools are mid-size central city, North Carolina public schools, grades 6-8. The third school is mid-size central city, North Carolina public magnet school, grades 6-10. The team school enrollment was 1,291 students during 2003-2004 and increased to 1,407 during 2004-2005. In 2004-2005 the percentage of students eligible to receive a free or reduced lunch based on family income status increased across all three schools. In two of the schools, the increase was an average of 14 percent, bringing the percentages of reduced/free lunch eligible students to 55 percent and 89 percent, respectively. In the magnet school, the percentage of reduced/free lunch eligible students in 2004-2005 was 41 percent, just a 6 percent change from the previous year. Overall, student diversity rose slightly from 50 percent minority to 54 percent minority in 2004-2005. (See Table 1 for more details.)

We examine schoolwide achievements at J71 in terms of the extent to which its NES implementation fulfills the six anticipated outcomes of the NES project as outlined below. This analysis is based primarily on the transcripts of two focus group interviews conducted by telephone with the J71 NES team. The first interview was conducted on Jan. 15, 2005; the second, April 27, 2006. We have also used school web site, survey data, and Department of Education statistics data to expand upon information provided in the interviews.

Here are some of the accomplishments achieved by NES J71 over its three years as a NASA Explorer School:

- J71 teachers are inspired by seeing NASA educators' and scientists' level of passion for what they are doing. The opportunity of attending different professional development workshops has helped teachers to network and meet with other educators. The discussion with other teachers gives J71 teachers fresh ideas for teaching and learning.
- J71 schools have established after-school robotics clubs and participated in the FIRST LEGO League with the assistance of NES personnel and funding.
- The partnership with NASA has brought tremendous publicity to the schools. It has made it easier for the schools to get other grants. For example, one of the schools was awarded two National Science Foundation grants and the other two schools were awarded Botball grants.

J71 team has addressed several challenges it has encountered with NES:

- A technical problem needed an on-site technician to fix the problem. The malfunction of videoconferencing equipment caused delays in the implementation process.

- Getting the community involved and willing to sponsor events in the schools has been difficult. NASA should be more responsive than just providing the school resources. The needs of the schools should be the priority more than anything else.
- Having three schools on the NES team is a challenge. Schools vary a lot even within the same district. Team turnover is also a challenge faced by the J71 team. For example, when the principal changes, the new principal either does not understand how the program was being implemented or does not buy in to the NES mentality.
- Having the district as the NES team is a challenge. Schools vary a lot even within the same district. For example, when a new principal comes on board, the person either does not know what was going on or does not want to do anything about NES. Turnover in the team is another challenge.
- Trying to get non-science or math teachers involved in NES has been a challenge. There is a lack of excitement from teachers who are not directly teaching science or math.
- There has been a problem communicating with NASA. The space agency has so many resources and material, yet finding the right thing sometimes is not possible or is too time consuming.

Below is a description of the degree to which this school has achieved the six anticipated outcomes of the NES project. The summary provides examples as to what types of professional development teachers participated in and to what extent they integrated NASA materials and resources into their classroom teaching.

Outcome 1: Increase participation and professional growth of educators in science.
The J71 team includes a district science facilitator and two science teachers. The team lead visits all of the schools bimonthly. School teachers meet twice a month.

The professional development workshops have opened up a lot of opportunities for the teachers. The teachers learn the science content knowledge as well as the technology. (See Table 3 for a list of NASA professional development opportunities completed by J71 teachers.)

> "A day with those high-level NASA scientists just amazed me that they would take a day and talk to teachers about how that whole project is being run" (Jan. 15, 2005).

> "One of the teachers who went to the History of Winter at Lake Placid came back and said that it was the best staff development experience she'd ever had. She's been teaching for probably 25 years" (Jan. 15, 2005).

> "I really enjoyed being able to see future research from morphing airplane wings that I saw on the Discovery Channel" (Jan. 15, 2005).

J71 observes both personal and professional gains through participating in the professional development workshops. The workshops also help teachers to become a part of learning community where they can watch one another teach, and support and learn from one another.

> "In the workshops we just get many chances to work with other people and get batteries recharged and hear different perspectives, somebody else's problems, rather than the same ones you hear all the time. That's as valuable to the teacher in a lot of ways" (Jan. 15, 2005).

> "Meeting the enthusiastic teachers and NASA scientists is most enjoyable. It reminds me that a lot of times the things that separate the very top of the line from the others is the passion they have for their work" (April 27, 2006).

One of the non-team member teachers went to the National Science Teachers Association (NSTA) conference and came back very excited. He told one of the team members that he is going to go to next year's NSTA even if he has to pay for it.

The team lead sees a renewal among other teachers. The team lead thinks they won't get that within their staff development programs.

J71 uses NASA resources to encourage students to learn different aspects of science. (See Table 4 for the NASA resources that J71 teachers incorporated into their instruction.)

A teacher has used the NASA web site to find specific things to build with LEGOs.

> "We've actually made replicas of the landers with balloons on the outside, and we threw them down a 50-foot drop on a parachute, let them bounce a few times, and then one of our LEGO robotics rovers would come out of it, just like with the NASA landings on Mars last year" (Jan. 15, 2005).

The aerospace education specialists (AES) have been instrumental in helping J71 to implement activities and events. They have initiated several staff development trainings with non-NES teachers and have worked on activities with individual students.

> "People from Langley have been down to do staff development training with all the teachers within our middle school science teachers. One AES came down and worked in the classroom. Another AES came to another middle school and did a day's activity where every grade level was with her for two periods. She spent three days at one school, one day with each grade level" (Jan. 15, 2005).

> "The AES have been excellent. Most of the problems that we have had tend to be with NASA headquarters or the education headquarters for NSTA" (April 27, 2006).

The NASA field center staff is not as helpful as J71 teachers want. Sometimes the information provided by them is not well suited for their students' needs, and a lot of times teachers have to spend extra time to search for the right materials for specific group of students. See Table 2 for the list of needs identified by J71 team in 2003.

Teachers communicate with field center staff via e-mail.

> The team lead mentioned, "Yes, but sometimes it may be too much. Sometimes I get those weekly e-mail blasts. Sometimes there is some important stuff in there that I ended up cutting and pasting it and sending it on to different schools, like about the videoconferencing where there is a new one to be set up" (Jan. 15, 2005).

Another teacher mentioned a lot of e-mails received are interesting, but NES doesn't send something that worked in a seventh grade math class to teach geometry or NES doesn't send how one can use the diameter of the moon to teach students about triangles.

> "NASA field center staff have been a great resource. We make very good use of the AES. They also do staff development for the school at the beginning and end of the year. Field center staff did the notebooks for every science teacher to try to narrow down what NASA has that fits our curriculum" (April 27, 2006).

In addition to our analyses from the J71 case study, we report some key findings from the survey data on J71. This data is meant to clarify and substantiate the teacher self-reported information used for the case study analyses.

For J71 we were able to pair two teacher pre-/posttest surveys and compare their mean scores with the overall mean of NES 2003 cohort teachers. Table 7 illustrates J71's mean and standard deviation on the Teaching, Learning, and Computing surveys compared with the NES 2003 cohort. Table 7 shows that J71 teachers showed much higher mean scores on the attitude toward technology while their mean scores regarding constructivist use of technology was lower than other 2003 NES teachers. This shows that teachers are not yet able to integrate technology into their instruction effectively to produce better learning outcomes.

In the team lead survey the team lead chose the ratings "somewhat satisfied" with the participation of the whole school faculty, "extremely satisfied" with NASA staff assistance for integration of NASA materials, and "satisfied" with NASA staff assistance for using inquiry.

Outcome 2. Increased assistance for and technology use by educators in schools with high populations of underserved students.
J71 purchased the following technologies with NES funding:

- Videoconferencing equipment
- Graphic calculator
- Robotics

There has always been a problem with the videoconferencing equipment.

> "The videoconferencing equipment was not working in one of the schools, so the school has to work with other two schools" (April 27, 2006).
>
> The team lead later found out that "[Some] company donated hundreds of videoconferencing equipment to NASA and then immediately withdrew them from the market and stopped giving support because it was a problematic piece of equipment" (April 27, 2006).

Outcome 3. Increased family involvement in children's learning.
Despite the difficulty of getting more parents to participate in student learning, teachers have made efforts to ensure that their students demonstrate what they are doing at school with their parents at home to increase parents' awareness of what the students are learning. This gives the parents more background knowledge so that they are better prepared to understand and participate when

they attend family events at the school. Several parents have concerns about the inconsistency of discipline and specifically about bullying. Some positive comments are about the use and availability of technology and good teaching practices.

> "Most of the parent involvement is having the kids do stuff at home with their parents. When they were designing robots to explore Mars, we wanted kids to make sure their parents saw it" (Jan. 15, 2005).

> "Because the school is a Title 1 school, we are really having a hard time to get parent involvement all around. But I think when the parents do come to one of our family nights, they enjoy the presentations" (April 27, 2006).

Searching for postings about J71 outreach and family events on the Internet, we found the following comments from parents of J71-A and J71-C students and students themselves:

> J71-A
> "This school is probably fine for those families who have one parent who can dedicate their time in tutoring their child at home, because if your child cannot 'get it' the first time, it will not be explained again. Don't let your child get left behind."

> "My daughter attends this school. She's in the sixth grade. I enjoyed the open house and tour; however, this school has not lived up to its potential. My daughter had some kids bullying her, and I contacted the school on numerous occasions. Well, it finally took for me to contact the administration offices before something finally was done. I thought this was a great school. But I found out some of the teachers don't care for the students, and the principal seems to always have something else to do than to assist parents and students. My daughter will not attend this school next year!"

> "J71-A is a great school with wonderful teachers. The use/availability of technology is outstanding!"

> "I am a student at J71-A and in the sixth grade. It has been tough at the beginning, but soon I caught up. J71-A is an excellent school, and I love all my teachers. There is a lot of homework, though, but if you pay attention in class, homework will go by like a breeze. I disagree with some of the parents' comments. I think that the food is very good, healthy, and warm. Also Ms. PC is a wonderful principal. What really stands out at J71-A is

the encore class robotics. This is my favorite class because you re basically playing with toys while you learn. We build cars out of LEGOs that run on a motor, build robots, program cars, and build house plans. The fun part is racing your car. This is a great school!"

"It was a rough start to the year. However, after meeting with the principal, who offered options and help, we were able to resolve our problem. My daughter loves it here....The students are bright and are independent thinkers. J71-A fosters the student's ability to think, reason and find resolutions. Yes, their course load is heavy, but it is nothing that ambitious middle schoolers aren't capable of managing. I would rather my child focus on their academics than fall prey to the vicious social scene that so many parents worry about. I think J71-A is not for everyone. Like most things it is a choice. Overall, I believe that the IB program is offering something good. I was a student in school overseas and my course load was more than students here, but it made for a well-rounded education. The school is good if given the chance."

"J71-A is now officially an I.B. School meaning if you attend J71-A 6-10 grade, then attend [school] high school 11-12 and receive your IB diploma, and middle years certificate, you can receive as much as two years off of college! This is a great school that challenges students. It is clean, well balanced, and full of caring, helpful, certified teachers that's only goal is to teach students and advance their knowledge. I don't know when these other parents kids went to J71-A, but as of now J71-A is a great school worthy of 5 STARS!"

"I feel that this school is overrated. Emphasis is placed on the parent teaching versus the teacher, given by the amount of homework given. Each additional grade level adds more and more homework to the point that the student has little if any time to work on any extracurricular activities. Homework can account for over 30hrs/week (more at times). There are two different teams. The administration holds that the teams are the same. It doesn't take too keen of an eye to see the obvious differences. My child will not go to this magnet school next year. I also echo the previous comment that I believe the principal is unresponsive to parents' concerns. That has been my experience."

"I'm a parent at the J71-A supposedly magnet school. J71-Ais supposed to excel in international connections. We do have VIF teachers, but not all students get to experience their teaching perspective, if any. Instead the overcrowdness sends talented students to an inexperienced teacher who

has no knowledge at all. The overall hygiene is absolutely unacceptable. The food is 97 percent of the time undercooked or cold. The principal doesn't care about the student approaches to learning. This is coming from a parent who clearly learns more efficiently in the afternoon, but when an important math class is assigned in the morning, there is an issue. When a request was put to change the class, the principal said 'And, what else is new'. SO do they really enforce ALL the elements of the 'IB' program?"

J71-C
"This is my first year at J71-C, and I really like it. It is an old school, but we have a great staff and principal. I haven't had any trouble at all this year. It's really great. The only bad thing is there aren't many extracurricular activities for sixth-graders."

"The teaching staff at this school 'could be' one of the best in the state IF it had the backing of the current administration. The AG program is very challenging. The music program is the best that I have firsthand knowledge of. As far as parent involvement, as with anything else, you have those who do, and those who don't. More those who don't at this school. Lack of consistency in discipline is the biggest factor."

"I have attended J71-C for the past two years and now I am in the eighth grade. This school has a great staff whose main goal is to help their students succeed. I would recommend this school to anyone!"

"This is my daughter's first year at J71-C and the first quarter she made honor roll and the principal's list with a GPA of 3.75. But there has been a lot of bullying going on with all the wrong punishment. The principal is wonderful, but there are a great deal of behavioral problems going on and no one is taking it serious enough to put an end to it! When a good student is put in the same class with a bad student, it's hard for the well-behaved children to do what is asked when others are disruptive. Home school might be a better choice!"

Outcome 4. Increased student interest and participation in STEM-G.
J71 has observed the change in students' interest when they participate in the LEGO robotics activity. Students are getting attention from the community for their use of state-of-the-art NASA technology. This boosts students' self-concept of how they see themselves and what they can do for in the future.

The following strands are indicators of what it means for students to have interest and to participate in STEM-G activities. Examples from teachers' observations are provided after each strand.

Participate productively in STEM-G practices and discourse.

> "Kids are excited about doing things by imitating tomorrow's rovers and doing the research and trying to figure out ways to make it look like something else, like another robot" (Jan. 15, 2005).

> "I can clearly see that more students are interested in things like engineering than they were before" (April 27, 2006).

Show noticeable curiosity in STEM-G-related topics and events.

One of the students posted her comments on the school reviewing web site, indicating that robotics class is her favorite class. She said, "We build cars out of LEGO that run on a motor, build robots, program cars, and build house plans. It is basically playing with toys while we learn." Hands-on activities are undoubtedly students' major source of interest in science lessons, and the reason is that they allow student involvement and encourage them to become active participants in learning.

Perceive stronger self-concept.

> "The NASA ambassador came and talked to all the classes at the sixth grade level. Kids' interests were so high" (April 27, 2006).

Actively participate in hands-on and authentic scientific research.

> "We do some of the things in robotics with NASA. A lot of it has to do with technology, and the kids really get excited about engineering" (Jan. 15, 2005).

Outcome 5. Increased student knowledge about careers in STEM-G.
Visits to the field center and discussions with scientists have helped students gain more knowledge about a variety of NASA careers, not just the career of an astronaut.

The following strands indicate students' knowledge about careers in STEM-G. Students who demonstrate knowledge about careers in STEM-G demonstrate:

Increased understanding of and enthusiasm about STEM-G careers.

> "Students have seen that their stereotype of what a person who works in science looks like. A lot of them have seen that it can be a person like them" (April 27, 2006).

> "Kids are excited about engineering. Some of them want to go and be an engineer, but there are others saying that 'I can build a robot, and I can program it. I don't want to go to a four-year college, but I want to do something where I get to do something with technology in my hands' " (Jan. 15, 2005).

Sharing information with their peers and parents.

> A teacher said, "I had one kid, and the mother told me that when we were doing the rover, he decided he wanted to be an engineer and that he wanted to go into space exploration. Then when we started working with making grasping hands to go on it, we built the base of the rover, and then we were building claws, his mother told me that maybe he decided he wanted to make the arms and hands, prosthetics for people" (Jan. 15, 2005).

Outcome 6. Increased student ability to apply STEM-G concepts and skills in meaningful ways.

No specific examples on student ability to apply STEM-G concepts and skills in meaningful ways were identified in the teachers' observations. However, in the student interest survey, students rated themselves as good at using math to explore solutions to problems and presenting the results of an investigation or project to the class. This shows that students were given opportunities to practice mathematic activities, and they actually felt that they were good at it.

As one of the case study schools, J71 was asked to take the student interest survey in spring 2006. Two percent of grades 4-6 and grades 7-9 students completed the questionnaire. J71 students had mean scores at least one standard deviation above the overall item mean scores in the following items:

- "Tell us how much you like…" geography (both 4-6, and 7-9 grades), social studies/history.
- "Rate how much you know about…"geography.
- "Rate how good you are at…" using math to explore solutions to problems, presenting the results of an investigation or project to the class.
- "How much would you like to have these jobs…" Engineer (7-9 grades).
- "How often do you or your teachers use NASA materials in…" technology education?

- "Tell us how often you think you will use math as an adult…" Going measuring and analysis (7-9 grades), in my job or career (7-9 grades).

For J71 students, Geography is a subject they like and they feel they know a lot about. In cases where teachers used NASA materials in technology education, students indicated they would like to have the job of engineer. Moreover, when students feel good at using math to explore solutions to problems, they tend to think they will use math in their career.

In the case of J71, the use of NASA materials is associated with students liking the job associated with the materials. J71 students felt confident using math to explore solutions to problems and in presenting the results of an investigation. They also indicated a higher tendency of believing that they will use these skills in their jobs as an adult.

School achievement scores for all three J71 schools are provided in Tables 5 and 6. Note that each set of school scores are listed as individual tables, so there are three sets of math and reading tables. The scores for J71A and J71C are consistently higher than the J71B math and reading scores. J71A is the magnet school and J71C is similar demographically to J71A (See Tables 1 A, B, & C). J71B, however, has more than double the percentage of low socioeconomic students and many more Hispanic students who are possibly English language learners.

NASA Explorer Schools Case Study Profile: J71
2003 Cohort North Carolina Public Schools—Grades 6-10

Table 1. School Demographics
J71-A (Grades 6-10)

	2003-2004	2004-2005
All students	504	576
Black, non-Hispanic	301	325
Asian	3	11
Hispanic	14	15
Indian, Alaskan Native	0	0
White, non-Hispanic	186	225
School location (rural, suburban, urban)	mid-size central city	mid-size central city
School type (public, private, charter, magnet)	public, magnet	public, magnet
Title 1 status (yes or no)	no	no
Free and reduced price lunch	35.71%*	41.32%**

*NCES. (2004). Search for public schools. Retrieved Jan. 29, 2007.
**NCES. (2005). Search for public schools. Retrieved Jan. 29, 2007.

J71-B (Grades 6-8)

	2003-2004	2004-2005
All students	511	545
Black, non-Hispanic	349	346
Asian	3	3
Hispanic	59	121
Indian, Alaskan Native	2	3
White, non-Hispanic	98	72
School location (rural, suburban, urban)	mid-size central city	mid-size central city
School type (public, private, charter, magnet)	public	public
Title 1 status (yes or no)	yes	yes
Free and reduced price lunch	75.93%*	89.17%**

*NCES. (2004). Search for public schools. Retrieved Jan. 29, 2007.
**NCES. (2005). Search for public schools. Retrieved Jan. 29, 2007.

NASA Explorer Schools Case Study Profile: J71
2003 Cohort North Carolina Public Schools—Grades 6-10

J71-C (Grades 6-8)

	2003-2004	2004-2005
Black, non-Hispanic	276	286
Asian	1	1
Hispanic	7	12
Indian, Alaskan Native	2	4
White, non-Hispanic	357	347
School location (rural, suburban, urban)	urban fringe of mid-size city	urban fringe of mid-size city
School type (public, private, charter, magnet)	public	public
Title 1 status (yes or no)	no	no
Free and reduced price lunch	38.72%*	53.54%**

*NCES. (2004). Search for public schools. Retrieved Jan. 29, 2007.
**NCES. (2005). Search for public schools. Retrieved Jan. 29, 2007.

Table 2. Summary of Academic Needs Identified by J71 in 2003

1	Physical Science: Transfer of energy
2	Physical Science: Motions and forces
3	Data Analysis and Probability: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
4	Design: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
5	Earth and Space Science: Structure of the Earth system
6	Measurement: Apply appropriate techniques, tools, and formulas to determine measurements
7	Data Analysis and Probability: Develop and evaluate inferences and predictions that are based on data
8	Technology and Society: Students will develop an understanding of the role of society in the development and use of technology
9	Algebra: Analyze change in various contexts
10	Earth and Space Science: Earth in the solar system

Table 3. NASA Professional Development Opportunities that J71 Teachers Completed

2003 NES summer orientation
2004 NES content workshop
2005 NES sustainability conference
NES update session during NSTA symposium
National Science Teachers Association
NCTM
NECC
History of Winter workshop
JPL robotics training workshop
LARC technology immersion workshop
Two team members went to Berkeley for training by UC Berkeley for a field test of SEPUP Curriculum Materials—Investigation in Earth Science—July 2004 and January 2005

Table 4. NASA Resources and Expertise That J71 Teachers Incorporated into Their Instruction

Robotics, Botball
Inquiry-based science curriculum
NASA personnel (NASA Ambassador, astronauts, AES, field center staff, ERC)
Lessons for math teachers
Astro-Venture
NASA web site
Rocketry

Table 5. Summary of J71 School Achievement Reading Test Scores

J71-A

Grade	Year	Min. Reading	Basic Reading	Prof. Reading	Adv. Reading
6	2003	23.2		76.8	
7	2003	21.2		78.8	
8	2003	13.5		86.5	
6	2004	16.9		83.1	
7	2004	10.7		89.3	
8	2004	9		91	
6	2005	12.3		87.7	
7	2005	9.7		90.3	
8	2005	6.3		93.7	
6	2006	13.8		86.2	
7	2006	8		92	
8	2006	10.8		89.2	

J71-B

Grade	Year	Min. Reading	Basic Reading	Prof. Reading	Adv. Reading
6	2003	38.1		61.9	
7	2003	26.7		73.3	
8	2003	22.7		77.3	
6	2004	40.7		59.3	
7	2004	19.7		80.3	
8	2004	20.9		79.1	
6	2005	46.6		53.4	
7	2005	32.4		67.6	
8	2005	24.2		75.8	
6	2006	56.7		43.3	
7	2006	35		65	
8	2006	30.9		69.1	

NASA Explorer Schools Case Study Profile: J71
2003 Cohort North Carolina Public Schools—Grades 6-10

J71-C

Grades	Year	Min. Reading	Basic Reading	Prof. Reading	Adv, Reading
6	2003	21.7		78.3	
7	2003	17.9		82.1	
8	2003	14.7		85.3	
6	2004	24.2		75.8	
7	2004	12.6		87.4	
8	2004	7.9		92.1	
6	2005	18.3		81.7	
7	2005	13.8		86.2	
8	2005	14.1		85.9	
6	2006	25.8		74.2	
7	2006	11.1		88.9	
8	2006	11.5		88.5	

Table 6. Summary of J71 School Achievement Math Test Scores
J71-A

Grades	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	16.6		83.4	
7	2003	25		75	
8	2003	18.7		81.3	
6	2004	10.4		89.6	
7	2004	17.8		82.2	
8	2004	10		90	
6	2005	9.9		90.1	
7	2005	13.7		86.3	
8	2005	12.7		87.3	

J71-B

Grades	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	19.3		80.7	
7	2003	43.8		56.2	
8	2003	30		70	
6	2004	25.9		74.1	
7	2004	29.9		70.1	
8	2004	39.3		60.7	
6	2005	25.3		74.7	
7	2005	29.1		70.9	
8	2005	31.4		68.6	

J71-C

Grades	Year	Min. Math	Basic Math	Prof. Math	Adv. Math
6	2003	8.6		91.4	
7	2003	19		81	
8	2003	18.3		81.7	
6	2004	11.4		88.6	
7	2004	8.9		91.1	
8	2004	7.8		92.2	
6	2005	8		92	
7	2005	13.4		86.6	
8	2005	13.7		86.3	

Table 7. Comparison of J71 and 2003 Cohort Teachers on TLC survey

	J71		2003 Cohort	
	M	SD	M	SD
Constructivist Teaching Philosophy (CTP)	3.43	0.14	3.29	0.4
Constructivist Teaching Strategies (CTS)	2.50	0.11	2.73	0.6
Constructivist Uses of Technology (CUT)	1.90	0.00	2.73	0.56
Technical Skills (TS)	2.56	0.35	2.99	0.49
Attitudes Toward Technology (ATT)	2.95	0.47	2.17	0.75

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
1			**2003**	**2003**	**2003**	**2003**	**2003**	**2003**	**2003**	**2003**	**2003**	**2003**	**2003**	**2003**
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
3		***TOTAL POINTS***	**74**	**56**	**77**	**52**	**74**	**64**	**66**	**78**	**78**	**73**	**67**	**68**
4	**Outcome 1: Participation and professional growth of educators in science**	**48**	**37**	**33**	**38**	**26**	**42**	**32**	**39**	**40**	**38**	**33**	**33**	**33**
5	*Guideline 1 - Instructional Strategies* *[data sources*: interview transcripts; surveys: TI, Adm, TLC; e-folio]*	8	5	6	7	3	7	5	6	7	7	6	6	6
6	*Guideline 2 - Time Intensive* *[data sources: interview transcripts; surveys: TL, TI, FC; e-folio]*	8	7	7	6	6	7	6	6	8	6	5	5	5
7	*Guideline 3 - Classroom Practices* *[data sources: interview transcripts; surveys: SI, TL, TI, FC; e-folio]*	8	7	5	6	5	7	7	7	7	6	6	6	6

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
8	*Guideline 4 - Content Knowledge* *[data sources: interview transcripts; workshop reports; surveys: TL, TI, FC; Admin; e-folio]*	8	6	4	6	5	6	4	7	6	5	5	5	5
9	*Guideline 5 - Active Learning* *[data sources: interview transcripts; workshop reports; surveys: TI, FC; Admin; e-folio]*	8	5	4	6	3	7	4	7	6	6	4	4	4
10	*Guideline 6 - Coherence* *[data sources: interview transcripts; workshop reports; surveys: TL, TI, FC; Admin; e-folio]* *Note that negative features have to be accounted for in the weight of variables.*	8	7	7	7	4	8	6	6	6	8	7	7	7
11	*Comments on Outcome 1:*													
12														

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
13	**Outcome 2: Assistance for and technology use by educators in schools with high populations of underserved students**	**16**	**10**	**4**	**13**	**1**	**4**	**7**		**8**	**7**	**8**	**7**	**5**
14	Guideline 1 - Selects, purchases, and uses technological tools with NES funding (which may be supplemented by or enhanced by other sources) [data sources: interview transcripts; technology plan; e-folio]	4	3	1	3	1	0	1	3	2	3	4	4	3
15	Guideline 2 - School-wide frequency of using technology tools in teaching and professional activities [data sources: interview transcripts; surveys: TL, TI, FC, TLC; e-folio]	4	3	1	4	0	1	3	4	3	1	1	1	1
16	Guideline 3 - Teachers report frequency of using the technology in STEM-G context [data sources: interview transcripts; surveys: TLC; e-folio]	4	1	1	3	0	2	1	1	1	2	1	1	0
17	Guideline 4 - Teachers report frequency of using the technological tools in preparation for teaching or other professional activities [data sources: interview transcripts; surveys: Admin, TLC; e-folio]	4	3	1	3	0	1	2	1	2	1	2	1	1
18	*Comments on Outcome 2:*					2.1: The videoconferencing equipment was purchased using NES								
19														
20														

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
21	**<u>Outcome 3</u>: Family involvement in children's learning** **[data sources: interview transcripts; workshop reports; surveys: SI, TL, TI, FC; Admin; e-folio]**	**10**	**8**	**7**	**7**	**7**	**6**	**8**	**4**	**7**	**8**	**8**	**6**	**7**
22	*Comments on Outcome 3:*					3: The school reports success with family involvement with its Star Party. But parent								
23	**<u>Outcome 4</u>: Student interest and participation in science, technology, engineering, mathematics, and geography**	**8**	**8**	**7**	**6**	**7**	**8**	**7**	**8**	**7**	**8**	**6**	**6**	**6**
24	*Guideline 1 - Participate productively in STEM-G practices and discourse* *[data sources: interview transcripts; e-folio]*	2	2	2	2	2	2	2	2	2	2	1	1	1
25	*Guideline 2 -Show noticeable curiosity in STEM-G related topics and events* *[data sources: interview transcripts; surveys: TL, TI, FC; e-folio]*	2	2	2	0	2	2	2	2	1	2	1	1	1
26	*Guideline 3 -Change attitudes about learning* *[data sources: interview transcripts; surveys: SI; e-folio]*	2	2	1	2	2	2	1	2	2	2	2	2	2

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
27	*Guideline 4 -Actively participates in hands-on and authentic scientific research* *[data sources: interview transcripts; surveys: SI; e-folio]*	2	2	2	2	1	2	2	2	2	2	2	2	2
28	*4.3: Did not take student interest survey*													
29	**<u>Outcome 5:</u> Student knowledge about careers in science, technology, engineering, mathematics, and geography**	**9**	**6**	**2**	**5**	**3**	**5**	**3**	**9**	**9**	**9**	**9**	**9**	**9**
30	*Guideline 1 - Change in self-identity* *[data sources: interview transcripts; surveys: SI; e-folio]*	3	3	2	3	0	2	1	3	3	3	3	3	3
31	*Guideline 2 -Increased understanding of and enthusiasm about STEM-G careers* *[data sources: interview transcripts; surveys: SI, TI; e-folio]*	3	3	0	2	2	2	1	3	3	3	3	3	3
32	*Guideline 3 -Share information with peers and parents* *[data sources: interview transcripts; surveys: SI; e-folio]*	3	0	0	0	1	1	1	3	3	3	3	3	3
33	*5.2, 5.3: Did not take student interest survey*			2		5.2: Compared with non-STEM-G carers, D106								
34	**<u>Outcome 6:</u> Student ability to apply science, technology, engineering, mathematics, and geography concepts and skills in meaningful ways**	**9**	**5**	**3**	**8**	**7**	**8**	**6**	**6**	**7**	**8**	**7**	**6**	**7**

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
35	*Guideline 1 - Understand and use scientific explanations of the natural world* *[data sources: interview transcripts; surveys: SI, TI, FC; e-folio]*	3	3	2	5	3	3	3	3	3	3	3	3	3
36	*Guideline 2 - Understand, use, and interpret the nature and development of STEM-G topics* *[data sources: interview transcripts; surveys: SI, TI; e-folio]*	3	2	1	1	2	2	2	3	3	3	3	3	3
37	*Guideline 3 - Increased achievement in math and language arts, reading, and science standardized tests* *[data sources: interview transcripts; State report card data]*	3	0	0	2	2	3	1	0	1	2	1	0	1
38	*Comments on Outcome 6:*					6.3: D106 met AYP; grades 2-4 performed well on state tests; but grade 5 was								

	A	E	F	G	H	I	J	K	L	M	N	O	P	Q
2		***Maximum Possible Points***	**A42**	**B1**	**C6**	**D106**	**E57**	**F18**	**G145**	**H99**	**I59**	**J71-A**	**J71-B**	**J71-C**
39														
40	**Bonus Points: *Great School Rating*** ***www.greatschools.net/***	**2**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**2**	**0**	**1**
41														
42	*Definition of Data Sources													
43	Interview transcripts:													
44	2003 NES school teams were interviewed in the spring of 2005													
45	2003, 2004, and 2005 cohort case study school teams were interviewed in the spring of 2006													
46	Surveys:													
47	SI: Student Interest - taken by case study schools, spring 2006													
48	TL: Team Lead - taken by all NES team leaders, spring 2006													
49	TI: Teacher Involvement - taken schoolwide by NES and non-NES teachers at all NES schools, spring 2006													
50	FC: Field Center Staff - disseminated to field center education staff at all 10 NASA centers, spring 2006													
51	Admin: Administrator - completed by NES team administrators, spring 2006													
52	e-folio: An electronic portfolio for the NASA Explorer Schools project <http://aesp.nasa.okstate.edu/efolio/>													