NASA Explorer Schools

2005 Cohort

Case Study Reports and Summary Rubric Scores

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NASA Explorer Schools Case Study Profile: A104
2005 Cohort—Urban Florida, Public High School: Grades 9-12

Summary Comments Regarding A104
A104 is a public high school on the urban fringe of a large city in Florida. A104 is a magnet school. It was selected as a NASA Explorer School in 2005. A104 serves a multi-ethnic community, and the student population reflects this diversity with its 44 percent Black and 20 percent Hispanic population. The percentage of students receiving free or reduced lunch increased from 29 percent to 37 percent between the 2004-2005 to 2005-2006 school years. See Table 1 for more information on the school demographics.

Here are some of the successes that A104 achieved during its three-year period as a NASA Explorer School:

- A104 has partnership with local business to support their students participate in the robotic competition.
- As a result of NES, A104 has opened some new curriculum to their students such as in Astronomy and Aeronautics, Robotics and Space Technology. A total of 90-120 students sign up for these new classes.
- A104 School has moved from not meeting AYP to provisional AYP in 2004-2005 year.
- A104 parents have credited many school successes to teachers' teaching quality and countless activities for students and family involvement such as School of Aerospace Technology, Moon Math Challenge, FIRST Robotics, and a NASA Science Night/Family Science Night.

As a school that serves a highly diverse population, A104 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- A104 non-team teachers have been difficult to engage. They don't have time to search for and review NASA resources or activities.
- Late funding caused delays in holding a family night focused around telescopes because the NES funding was slated to purchase telescopes.
- A104 students don't take the next step to get involved. The magnet school students don't' want to stay for after-school activities because they'll get home late and then they don't have time to do their homework or study, and their priority is to do well academically.
- Lacking a clear focus, it difficult for A104 teachers to select resources to support activities for the whole school or families.

We examined schoolwide achievements at A104 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 transcript of a focus group interview conducted by telephone with the A104 NES team on April 25, 2006. We have also used school website, survey data, NES e-Folio website, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES A104 team was formed in 2005. The current team lead joined the team as a teacher, but now serves as team administrator since he has accepted the position of assistant principal. The team teachers cover grades 9 through 12. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation A104 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 the NES Kickoff, creating a School of Aerospace Technology, Moon Math Challenge, FIRST Robotics, and a NASA Science Night/Family Science Night. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that A104 has taken advantage of as a NASA Explorer School.

In their online digital portfolio, the A104 team highlights the professional development plan they have arranged with their NASA field center education specialists. "Ten times each year two NASA specialists will visit [A104] to teach students and conduct staff development workshops for faculty. Students will also utilize videoconferencing equipment to connect with NASA astronauts, scientists and engineers across the country on an ongoing basis. The school will even have an opportunity to link-up, live, to the International Space Station. Students will also have educational travel opportunities. An example involves students designing an experiment that will be flown in a rocket, then attending the rocket's launch."[1]

[1] Source: NASA Explorer Schools Digital Portfolios. Retrieved on July 19, 2007 from http://aesp.nasa.okstate.edu/efolio.

The next section examined the extent to which the A104 school implementation of NES addresses two of the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.
As a member of the NES 2005 cohort, A104 completed its first year in the program during the 2005-2006 school year. At this point we point to some of the A104 plans and strategies, without having a lot of documentation regarding the outcomes and impact of these plans. Here is what the A104 propose as their instructional strategies to create learning environments that immerse students in NES opportunities:

- "Our NES team is committed to teaching our students how to not only learn concepts, but how to apply them in hands on, real world scenarios. Our teachers will work collaboratively to produce lessons that will require our students to do this. Not only will our students learn, but they will be armed with the skills to implement what they know."2
- "Our partnership with NASA will allow us to offer an unparalleled curriculum in the STEM-G fields of study" (e-Folio, 2007).

After completing almost one year in the NES program, teachers were able to notice how the professional development experiences helped them apply their own content knowledge gains to their classroom teaching. Here's one teacher's description of this process.

- "I gained a tremendous amount of knowledge from the workshops. The knowledge has transferred into my teaching (Focus Group Interview, April 25, 2006).

In addition to our analyses from case study, we report some key findings from the survey data on A104. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, two teachers responded "sometimes," and one teacher responded "almost everyday" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or

[2] Source: NASA Explorer Schools Digital Portfolios. Retrieved on July 19, 2007 from http://aesp.nasa.okstate.edu/efolio.

task, two teachers responded "sometimes," and one teacher responded "almost everyday" in the TLC survey.

- Here is how teachers responded to questions in the TLC survey regarding how often they accomplish the following goals:
    - Elicit students' ideas and opinions: One teacher responded "always," one teacher responded "often," and one teacher said "sometimes."
    - Get students to justify and explain their reasoning: One teacher responded "always," one teacher responded "often," and one teacher said "sometimes."
    - Have students relate what they are working on to their own experience: One teacher responded "always," one teacher responded "often," and one teacher said "sometimes."
- Four teachers completed the Teacher Need and Involvement survey. In responding to how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, one teacher said "a lot," two teachers said "quite a bit," and one teacher said "a little."

Guideline 2. Time Intensive.

The A104 team began their NES experience with a commitment to devote extended time to the professional development opportunities made available to them. They also desired to build on the NASA partnership and seek additional STEM-G partnerships with related industry and agency contacts in their community. Here's the A104 vision statement about their level of commitment to sustained professional growth again from their NES digital portfolio:

- "Our students will not be the only benefactors of this new partnership. Our faculty will also be exposed to quality professional development on a continual basis. We will invite our aerospace education specialist to present workshops to our staff. We will also utilize videoconferencing to attain our goal. Our NES team will also focus on forming partnerships with other leaders in the aerospace industry. Our entire staff will benefit from the professional development opportunities afforded to them."
- "Ten times each year two NASA specialists will visit A104 to teach students and conduct staff development workshops for faculty" (e-Folio, 2007).

Below are administrator and teacher comments on professional development experiences that they have completed as of Spring 2007.

- "It made me much more interested in bringing space technology to students. I applied for the administrator conference (Oct/Nov). It will help

me to meet other administrators to share best practices and to learn how they have implemented the program at their schools" (Focus Group Interview, April 25, 2006).

- "I gained a tremendous amount of knowledge from the workshops. The knowledge has transferred into my teaching (Focus Group Interview, April 25, 2006).
- "Several teachers (2-3) have gone to conferences. (Focus Group Interview, April 25, 2006).
- NASA Staff Development: "Teachers will be exposed to the exciting NES program. Teachers will be given an overview of the opportunities available to them through this program (e-Folio, 2007).
- Video Conferencing: "Teachers will participate in a professional development workshop on using video conferencing (e-Folio, 2007).

When asked in the Teacher Involvement survey (Spring 2006) about their level of involvement in the NASA Explorer School program, here is a summary of A104 teacher responses:

- How many NASA STEM-G activities have you used in your classroom this year? One chose 30+; one chose: 1-5; one chose 1-5.
- How much have you participated in the following NASA activities this year?
    - Professional development: Both chose 1-5 times.
    - Schoolwide events: Both chose 1-5 times.
    - Use of NASA materials in your own classroom: One chose 16-30 times; one chose 1-5 times.
    - Shared what you learned with your colleagues: One chose 16-30 times; one chose 1-5 times.
    - DLN events: One chose 1-5 times; one chose not at all.

When asked, "How much do you agree with the following?" A104 teachers responded with the following ratings:

- The NES program has been a valuable experience for you: Both chose "a lot."
- This program has been inspiring to you: Three chose "a lot;" one chose "some."
- You applied what you learned from being a part of the NES program: Both chose "a lot."
- You integrated NASA-related materials into your curriculum: One chose "a lot;" one chose "quite a bit."
- This program has been inspiring to students: Both chose "a lot."

- The NES program has been a valuable experience for students: Both chose "a lot."

The A104 teachers who responded to this survey report using an above average number of NASA activities in their classrooms. These teachers rate the value of the program and to their students higher than the overall averages which reflects their commitment and enthusiasm for the program.

Guideline 3. Classroom Practices.
In June 2007, A104 instituted what they call The NES Freshman Academy to deal with the transition of students from middle school to high school. This new A104 program will have a major impact on how the NES project is implemented. Here is A104 team's description of the rationale and instructional approach for this new initiative that is being created within the context of the NES program:

- "Statistics show that 35% of these students will drop out before they reach the tenth grade. Another 25% will leave in the following year. Faced with these statistics, dynamic and immediate reform is mandatory for the survival of America as we know it."[3]
- For the 2007-2008 schoolyear,all incoming ninth grade students will be grouped into a cohesive learning community staffed by select members of the A104 staff.

Guideline 4. Content Knowledge.
The interview statements, survey reports, and digital portfolio entries show that the A104 team brings a great deal of enthusiasm and determination to their participation in this program. The Teacher Involvement survey responses completed by two members of the A104 team indicate that one and to some extent both teachers have a lot of confidence in their abilities to teacher science and engineering concepts and in their integration of NES activities.

When asked in the Teacher Involvement survey (Spring 2006), "How comfortable you are teaching concepts in the following areas?" the A104 team responded with the following comfort ratings (5=A lot to 1=not at all):

- Science: One selected "a lot;" one selected "quite a bit."
- Educational Technology: one selected "quite a bit."
- Engineering/Technology: One selected "a lot;" one selected "a little."
- Mathematics: One selected "a lot;" one selected "a little."

[3] Source: NASA Explorer Schools Digital Portfolios. Retrieved on July 19, 2007 from http://aesp.nasa.okstate.edu/efolio.

- Geography: One selected "a lot;" one selected "some."

The above listed A104 team ratings for their confidence in integrating STEM-G career education and using inquiry are above the overall case study mean rating which are 3.35 and 3.68 respectively. The ratings above also show that A104 feel more confident in teaching science and engineering/technology concepts than the average NES school.

Guideline 5. Active Learning.

The new freshman academy being instituted at A104 will provide a guiding framework for integration of NES activities with A104 academic goals. The Teacher Involvement survey data shows that not all A104 teachers bring the same level of commitment to their participation in the NES project. Both teacher ratings show a commitment to integrating educational technologies from the teaching and learning perspective.

When asked in the Teacher Involvement survey (Spring 2006), "How much have you changed in each of the following areas as a result of being in a NASA Explorer School?" the A104 team responded with the following ratings (5=A lot to 1=not at all):

- Integrate more STEM-G careers education into the curriculum: One selected "a lot;" one selected "quite a bit."
- Integrate more technology use by students: One selected "a lot;" one selected "quite a bit."
- Integrate more technology into your instruction: One selected "a lot;" one selected "quite a bit."
- Incorporate inquiry activities in your instruction: Both selected "a lot."
- Align instructional approaches to reflect national/state standards: One selected "quite a bit;" one selected "not at all."

Guideline 6. Coherence.

The following excerpts from the A104 profile on the NES digital portfolios website shows that this school is thinking about sustainability issues from the start.

- We will create a promotional video to create student and faculty buy-in. We feel this is a critical step to the future success of our program.
- We will utilize the remaining technology funds to purchase equipment that will excite our students as they work with cutting edge technology.
- Our NES team will develop relationships with local industry leaders and universities with the goal of creating a "speakers circuit." These partners

will come into the school and provide our students with the knowledge of the opportunities that await them in the STEM-G fields.

- These partnerships will last throughout our time with the NES program and eventually offer student internships. Our strategic plan will also heavily focus on the careers that are the most prevalent in the South Florida area.
- Our faculty will also be exposed to quality professional development on a continual basis. We will invite our aerospace education specialist to present workshops to our staff. Our entire staff will benefit from the professional development opportunities afforded to them.
- We will also utilize videoconferencing to attain our goal. Our NES team will also focus on forming partnerships with other leaders in the aerospace industry.

Summary of How A104 Meets Outcome 1.
NES A104 teachers bring a vision to their participation in NES that includes adopting strategies and resources gained from professional development workshop to their classrooms as well as shared with other non-NES teachers, but also extends to years after participation in NES. The teachers value the experience from attending various types of workshop and plan to participate distance workshops.

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

The A104 team purchased the following technologies with NES funding:

- Meade Telescope
- Camera Adapter for Telescope
- Canon EOS Digital Rebel XT SLR
- Lego Robotics Kit
- Camera Adapter
- Flash Card
- Desktop iMac
- Camera
- After Effects software for MAC
- After Effects software for Windows
- Maya Unlimited Student Software Bundle
- 32-Seat Bundled Kit Response Card XL
- vPad

The purchase of a Lego Robotics kit has enabled A104 to incorporate robotics into the school curriculum. The teacher in charge of robotics was made aware that robotics workshops were available through the NASA Explorer Schools program by the evaluator during the Focus Group Interview (Focus Group Interview, April 25, 2006). However without knowledge of the NES robotics training, the A104 teacher had already developed a robotics curriculum, entered student teams into robotics competitions, and developed a partnership with Motorola through robotics, as well as applying for and receiving a grant from FIRST Robotics.

- Video Conferencing: "Teachers will participate in a professional development workshop on using video conferencing (e-Folio, 2007).

NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate more inclusive picture of how A104 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "11-20 times" a year. Teachers also responded only "1-5 times" for using NASA materials in their classroom in a year.

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

As documented in NES e-Folio website, students and their families will turn A104 into one big science lab. Exciting activities will take place through the night with the goal of bringing families together for science.

Searching for postings about A104 outreach and family events on the web, we found the following comments from parents of A104 students. A104 parents are positive about the school program, staff, and teachers and delight to know that school offers variety of curriculum. The parents also express that hands on experience motivates their children to learn.[4]

> "My senior graduates in May. I was concerned, when we first moved here from New York, that the high schools didn't require the students to choose

[4] The Great Schools website lists overall positive comments from parents of A104 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 2, 2007 from http://www.greatschools.net/).

a sequence (4 yrs. of a chosen major), but the JROTC program proved to be the perfect solution. I think A104 has the best JROTC program because it concentrates on academics as well as drills, leadership and citizenship. I plan to remain with the program, even after my senior graduates. My only problem...I would love to see a dress code in the school" (April 2007).

"My son is finishing 10th grade in the Magnet Program at A104. I was very reluctant to send him initially to such a big school on the opposite side of town, as he was in a small elementary school run by our city. However, since our very first interaction with the faculty and staff at the school, my son and I have been thrilled. The magnet program classes and teachers are top notch, keeping things interesting for the students. Field trips provide hands on learning as well as a bonding experience for the students. There are a great number of extracurricular activities, providing something for everyone, regardless of their interests. I have also volunteered at many events, and feel in touch with school issues through the PTSA meetings and the parent newsletter that is mailed home. The open door policy really exists at A104, from administration to guidance to the teachers" (May 2006).

"This school offers a great learning experience for any child. The academics are wonderful, the availability of extracurricular activities are countless, and parent involvement is a+" (August 2005).

"Great school. good programs and clubs. Excellent magnet program (everglades restoration). Friendly teachers, unique clubs too" (April 2005).

"A104 is a good school with a lot of student and teacher involvement. I have a daughter who attends this school and is receiving a top education" (April 2005).

"Personally, I find A104 to be overcrowded as far as schooling goes, but they maintain an excellent education and have great teachers" (August 2004)

"I think that A104 is a great learning environment for the students that go there and that their principal is doing a good job by implementing certain things to bring up the fcat scores in the school like reading days and the AR books project and other projects to boost up the kids so they will

perform better on the fcat" (May 2004).

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

A104 NES team members have noticed increased interest, awareness, and growth among their students. They have record numbers of 90 to 120 students signed up for the new classes about space science and technology.

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

- FIRST Robotics: "A104 will compete in the 2006-07 FIRST robotics competition for the second year in a row. NASA has supported us with grants for the competition each year. We have also formed a partnership with Motorola and our students will be learning from the best engineers in the workplace today. Students will work for several months on robotics, culminating with the FIRST competition (e-Folio, 2007).

Show noticeable curiosity in STEM-G related topics and events

- When asked, "What has been the impact of these changes on their students?" an A104 team member stated, "Definitely interest. At the beginning of the school year one kid wanted to be a movie producer – now he wants to be an astronaut. There is more awareness of what is going on in this world and outside of this world due to NASA (Focus Group Interview, April 25, 2007).

Attitude changes about learning

- An A104 team member stated, "I have not documented student growth, but I have seen growth (Focus Group Interview, April 25, 2007).
- "We are excited to be in the program. We are trying hard to implement. The new classes will provide a sustained chance for students to learn about space science and technology. We have 90-120 kids signed up for the classes [daily instruction]" (Focus Group Interview, April 25, 2006).

- "We have 90-120 kids signed up for the classes [daily instruction]" (Focus Group Interview, April 25, 2006).

Active participation in hands-on and authentic scientific research

- "Ten times each year two NASA specialists will visit A104 to teach students and conduct staff development workshops for faculty. Students will also utilize videoconferencing equipment to connect with NASA astronauts, scientists and engineers across the country on an ongoing basis. The school will even have an opportunity to link-up, live, to the International Space Station. Students will also have educational travel opportunities. An example involves students designing an experiment that will be flown in a rocket, then attending the rocket's launch" (e-Folio, 2007).
- Moon Math Challenge: "Students will be participating in the Moon Math Challenge. This is a multi-disciplinary project that is hands-on and exciting" (e-Folio, 2007).

Outcome 5. Increased student knowledge about careers in STEM-G.

Anecdotal evidence was provided by A104 teachers to document changes in student attitudes regarding 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

- "At the beginning of the school year one kid wanted to be a movie producer – now he wants to be an astronaut. There is more awareness of what is going on in this world and outside of this world due to NASA (Focus Group Interview, April 25, 2006).

Increased understanding and enthusiasm about careers in STEM-G

- FIRST Robotics: "A104 will compete in the 2006-07 FIRST robotics competition for the second year in a row. NASA has supported us with grants for the competition each year. We have also formed a partnership

> with Motorola and our students will be learning from the best engineers in the workplace today. Students will work for several months on robotics, culminating with the FIRST competition (e-Folio, 2007).

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

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

As a Florida public school, A104 follows the state annual yearly progress goals. Florida uses School Grades to measure the overall performance of a school each year on the FCAT. Each school is assigned a letter grade (A-F) based on three criteria: the overall performance on the FCAT, the percentage of eligible students who took the test, and whether or not students made progress in reading and math. The annual yearly school progress school grades are calculated by adding points earned from each performance criteria. The Florida Department of Education gave A104 "C" in 2006-2007. In 2005-2006, this school received a "B." In 2004-2005, this school received a "C."[5]

The 2005-2006 Florida School Report Card showed improvement over 2004-2005, moving A104 from Not Meeting annual yearly progress (AYP) to Provisional AYP.[6] A104 still needs to improve the Reading scores for their student populations of Black, economically disadvantaged, and students with disabilities. In the area of Math, scores need to be improved for the A104 student population of students with disabilities. A104 did not meet the criteria of 83% of students meeting state standards in Writing.

Tables 5 through 7 provided details of A104 state standardized testing (FCATs). A104's 11th grade science test scores are 10% higher than the state average. Math scores for A104's 10th grade are 9% higher than the state average, while the 9th grade scores are 5% higher than the state average.

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[5] Source Great Schools: The Parents' Guide to K-12 Success. Retrieved on July 19, 2007 from http://www.greatschools.net.
[6] A104 2004-2005 Report Card. (2005). Florida Dept. of Education. Downloaded 10-4-2006 from http://schoolgrades.fldoe.org/.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	NA	2625*	2585	NA
Black, non-Hispanic	NA	45%*	45%*	44%**
Asian	NA	2%*	2%*	2%**
Hispanic	NA	17%*	19%*	20%**
Indian, Alaskan Native	NA	Less than 1%*	Less than 1%*	Less than 1%**
White, non-Hispanic	NA	35%*	33%*	32%**
Multi-Racial	NA	NA	NA	1%**
School location (rural, suburban, urban, mid-size central city)	NA	Urban Fringe of Large City*	Urban Fringe of Large City*	NA
School type (public, private, charter, magnet)	NA	Public	Public	NA
Title 1 status (yes or no)	NA	No*	No*	NA
Free and reduced price lunch	NA	37%*	29%*	37%

*National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 2, 2007 from http://nces.ed.gov/ccd/bat/

** The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 2, 2007 from http://www.greatschools.net/

Table 2. Summary of Academic Needs Identified by A104 in 2005

Priority	Discipline	Category	National Standard
1	National Educational Technology Standards		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.
2	National Educational Technology Standards		Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum.
3	Standards for Technological Literacy	Design	Students will develop an understanding of the attributes of design
4	Standards for Technological Literacy	Design	Students will develop an understanding of engineering design
5	Standards for Technological Literacy	Technology and Society	Students will develop an understanding of the effects of technology on the environment
6	National Science Education Standards	Earth and Space Science	Objects in the sky
7	National Science Education Standards	Physical Science	Motions and Forces
8	Principles and Standards for School Mathematics	Algebra	Understand patterns, relations, and functions
9	National Geography Standards	The world in spatial terms	How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
10	Principles and Standards for School Mathematics	Connections	Recognize and apply mathematics in contexts outside of mathematics

Source: A104 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that A104 Teachers Completed

NES Kickoff Program
Ten visits annually from two NASA specialists to conduct staff development workshops for faculty
NES off-site professional development
NES Administrator Conference
Workshops/Conferences (not specified)

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That A104 Teachers Incorporated into Their Instruction

NES staff support (field center, AES)
Education Guide on Rocketry

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. A104 FCAT Grade 9 Scores

	Reading	Math
2003	34%	51%
2004	36%	60%
2005	40%	64%
2006	41%	64%
State Average in 2006	40%	59%

Source: FCAT Results. (2005-2006). Florida Dept. of Education. Downloaded 05-02-2007 from http://www.firn.edu/doe/

Table 6. A104 FCAT Grade 10 Scores

	Reading	Writing	Math
2003	38%	92%	64%
2004	38%	97%	69%
2005	32%	93%	67%
2006	37%	NA	74%
State Average in 2006	32%	90% State Average in 2006	65%

Source: FCAT Results. (2005-2006). Florida Dept. of Education. Downloaded 05-02-2007 from http://www.firn.edu/doe/

Table 7. A104 FCAT Grade 11 Scores

	Science
2003	-
2004	-
2005	-
2006	45%
State Average in 2006	35%

Source: FCAT Results. (2005-2006). Florida Dept. of Education. Downloaded 05-02-2007 from http://www.firn.edu/doe/

NASA Explorer Schools Case Study Profile: B72
2005 Cohort—Rural, Alaska Public Elementary Schools: Grades K-6

Summary Comments Regarding B72
The B72 team is made up of two rural, public elementary schools located in Alaska. Both schools serve students in grades K-6 who student population is primarily White and are close to 50% free and reduced lunch eligible. See Table 1 for additional demographic details. The B72 school district covers approximately 25,600 square miles. The schools are located about 30-40 miles apart.

Here are some of the successes that B72 achieved during its three-year period as a NASA Explorer School:

- Each B72 NES team member implemented a NASA program into their classroom that had not been used before at their site.
- B72 has aligned NES activities to accomplish their Title I goals. Family math and science nights are also part of the Title I family implementation nights. Title I supported NES integration schoolwide while NES supported Title I goals.
- The partnership with local business has helped B72 team implementing some of the NES project and has also increased the family and community involvement.

As a school that serves a large poor population and which has limited access to resources due to location, B72 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- B72 was not able to implement plans involving technology as they had planned because the funds did not arrive on time.
- B72 found it a challenge to find time to train teachers to use new technology as well as addressing the varying comfort levels the teachers had with technology.
- The B72-B school administrator was officially on the NES team and attended the orientation workshop. At B72-B, in-service time is dedicated toward NASA-specific training. At B72-A, the school administrator is an unofficial team member and did not attend the orientation workshop. At B72-A, in-service time was not made available for NASA-specific training.
- Distance between the team schools (30-40 miles apart) and the different cultures at each school was a challenge for the B72 team. They addressed this issue by planning joint projects where team members traveled to both schools to help with the kickoff events and math and science nights. They also use email and have plans to use videoconferencing equipment to facilitate communication.

We examined schoolwide achievements at B72 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 transcript of a focus group interview conducted by telephone with the B72 NES team on April 27, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES B72 team was formed in 2005 with five members distributed between the two team schools. B72-A was home to three team members including two teachers and a school administrator. B72-B was home to two teachers and a school administrator. The original team lead left to serve as an Einstein Fellow with the National Science Foundation. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation B72 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 NES kickoff, and family math and science nights. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that B72 has taken advantage of as a NASA Explorer School.

The next section examined the extent to which the B72 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

The B72 teachers describe their expectations and overall goals for their participation in NES: "Our expectation was that we would gain new access to NASA materials, NASA resources, NASA expertise in such a way that we could ramp up our, specifically math and science education. That's really our focus, although we've also used it in geography and a couple other subject areas as well. But, if I was to give you the short version that would be our expectation would just be increased access and training for the teachers for things they could do with their kids" (Focus Group Interview, April 27, 2006).

Here are more specific curriculum and professional development goals:

- "The one specific goal we have created to meet our third NES objective will expand the entire school year and will include all staff members. Staff will use NASA resources and support to provide students with inquiry-

based science lessons. Through this we will integrate data analysis and investigation in all science areas of the scientific process."[1]

- "Our professional goals have already been implemented. We began our year with a DLN that focused on inquiry-based science instruction. We will have five STEM-G related professional development opportunities from NASA that are being taken advantage of by our staff. Our goal is to have staff who is not part of the team, but a vital part of our school community, share what they have learned and implement new and exciting STEM-G based instruction in the classroom. We also have several teachers training for the project 3-D View, as well as our quest programs working with scientists to improve and expand their knowledge for the reduced gravity project."[1]
- "We also hope to utilize a number of the inquiry based GEMS units to give our students better opportunity to explore and complete real scientific experiments" (e-Folio, 2007).
- Two B72-A teachers attended a Technology Immersion Workshop. "Teachers learned how to use a variety of technology tools such as handhelds, video recording, robotics kits, and video editing programs. They designed inquiry lessons to share and take back to their home schools."[1]

In addition to our analyses from qualitative data sources, we integrate findings from the surveys completed by the B72 team The survey data provides insight into what B72 teachers have done thus far to integrate NASA materials and teaching strategies that they have been exposed to through the professional development activities.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, two teachers responded "1-3 times per week," one responded "almost everyday ," and one responded "1-3 times per moth" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or task, two teachers responded "almost everyday," one responded "1-3 times per week ," and one responded "sometimes" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often they accomplish the following goals:
    - Elicit students' ideas and opinions: Two teachers responded "very often ," and two responded "always."

[1] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007, from http://aesp.nasa.okstate.edu/efolio

  - Get students to justify and explain their reasoning: Two teachers responded "very often ," and two responded "always."
  - Have students relate what they are working on to their own experience: One teacher responded "always ," one said "very often ," one said "often ," and one said "sometimes."
- Four teachers completed the Teacher Need and Involvement survey. In responding to how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, one teacher said "quite a bit ," two said "some ," and one said "a little."

Guideline 2. Time Intensive.

The excerpts below show what the B72 team has learned from the NES professional development activities, what resources they have integrated, and to what extent they have shared these opportunities and materials schoolwide and with other schools in their area.

- "As the new year begins we are sharing our team experiences with other staff, and providing the support they will need to achieve success with STEM-G concepts. Additional staff will also take advantage of several of the professional development opportunities that NASA has offered."[1]
- "Our professional goals have already been implemented. We began our year with a DLN that focused on inquiry-based science instruction. We will have five STEM-G related professional development opportunities from NASA that are being taken advantage of by our staff. Our goal is to have staff who is not part of the team, but a vital part of our school community, share what they have learned and implement new and exciting STEM-G based instruction in the classroom. We also have several teachers training for the project 3-D View, as well as our quest programs working with scientists to improve and expand their knowledge for the reduced gravity project."[1]
- "Team members will also be providing regular in-service opportunities, ranging from short briefings during faculty meetings, to extended in-service opportunities related to NASA programs and related technology."[1]
- "I think for any educator, when you feel that you're growing and providing cutting edge opportunities for your kids, I think that just for yourself is personally motivational that feels good, you like to do that, you feel better about yourself when you get up in the morning and parents feel good about it. They know that this is something special that their kids are getting and the NASA name carries so much positive energy with it. When the kids say, "Hey, we're doing one of those NASA projects today."

Could be the same old project with the NASA label, somehow that makes it better" (Focus Group Interview, April 27, 2006).

- "The 2006 NASA Leadership Academy provided NES administrators the opportunity to work with NASA specialists in the areas of research, instruction, professional development, science, engineering, technology and mathematics."[1]

The B72 team has found their support from NASA field center staff quite helpful—even though they don't always get immediate answers to their questions. Here's how the team describes field center support:

- "We have two support people, actually probably three that would be key to mention, one…is based out of Anchorage…[she] has been fantastic …as our instate contact. She and I have regular e-mail contact, usually see each other about once every three weeks it seems and her role has been, if we want something, if we ask for something, she finds a way to make it happen for us and usually is going beyond that saying here's another that I can bring you, here's another opportunity that I can bring you. Sometimes, to the point it can be a little overwhelming but we've also encourages her, hey, keep it coming, we'll, if it's too much, we'll say no. So, she's been great.
- "We've had support from… the assigned AES to our area. He came up in the fall for a week and did a series of trainings with us. He's constantly sending us more resource information as well, though we don't quite as tight a contact…it's not a face to face relationship…he's coming up again in May to do some professional development training with whatever staff members are available. It's going to be probably quite a bit of training out at B72-A because that's been pushed by their administrator. Here in this building it's "Gee, we're kind of busy." I don't think we have time for Brian to do stuff and I can't get teachers released and so I'm not sure exactly how well he'll be utilized in our building. I know [teacher] and I will use him, but beyond that I don't know" (Focus Group Interview, April 27, 2006).
- "I would rate [field center support] as excellent. We do have a third NASA [education specialist who is based in California who is also available to provide assistance], and in the fall his support was excellent in terms of he was constantly sending us things, reminding things, we could get him on the phone and kind of get answers to the questions. I think he's gotten overwhelmed this spring just in terms of trying to get information, like, about the student symposium or money issues, or what paperwork we should be filing is about a 2 to 3 week lag from the time we start trying to get him until we get an answer and that's been frustrating because I thought he was our primary contact for those kinds of questions, but I'm also understanding and I think that, that lag is all the way up to

> Headquarters in Washington, DC. I don't think he's getting the answers to pass on to us either so. So, in general, I'd say, Brian's support has been good and probably as good as he's able to give us. If that makes any sense?" (Focus Group Interview, April 27, 2006).

Three Teachers from both schools partnering in the B72 NES program completed the Teacher Involvement (Spring 2006) survey. When asked about their school's level of involvement in the NASA Explorer School program, here is a summary of this teacher's responses:

- How many NASA STEM-G activities have you used in your classroom this year? Response: Three chose "6-15."
- How much have you participated in the following NASA activities this year?
  - Professional development: Three chose "1-5."
  - Schoolwide events: Three chose "6-15."
  - Use of NASA materials in your own classroom: Two chose "6-15"' One chose "1-5."
  - Shared what you learned with your colleagues: One chose "6-15"; Two chose "1-5."
  - DLN events: Three chose "1-5."

When asked, "How much do you agree with the following?" The B72 teachers responded with the following ratings:

- The NES program has been a valuable experience for you? Two chose "quite a bit"; one chose "some."
- This program has been inspiring to you? One chose "a lot"; two chose "quite a bit."
- You applied what you learned from being a part of the NES program? One chose "a lot"; one chose "quite a bit"; one chose "some."
- You integrated NASA-related materials into your curriculum? Two chose "quite a bit"; one chose "some."
- This program has been inspiring to students? One chose "a lot"; Two chose "some."
- The NES program has been a valuable experience for students? One chose "a lot"; one chose "quite a bit"; one chose "some."

Guideline 3. Classroom Practices.

The B72 team explains how they coordinate their classroom implementation of NES as two school sites: "We're two schools and so one school's administrator is on the team, the other is informally on the team, but wasn't down at the training at Field Center B and we only hooked up and talked by phone about implementing the strategic plan and so we thought we had commitment that our in-service days this year were going to be focused around implementing NASA

Explorer School things that we'd do trainings on some of the technology, allowing other teachers to learn it and in the fall she changed the focus and so we've had no in-service time accessible for NASA training all year and so that's been a challenge" (Focus Group Interview, April 17, 2006).

- "…just two weeks ago [AES], our NASA advisor from Anchorage, actually came down and she did a set of activities as part of NASA night. These are nights we're always giving away the NASA Explorer School goodies. It's kind of motivating. Usually there's some kind of NASA theme that jells that whole night together" (Focus Group Interview, April 27, 2006).
- "…team members found it easy to select materials and be involved just because we had such a great exposure to it down at Field Center B. We've made these all school events, we're trying to involved all teachers and some teachers found it difficult to figure out what exactly what we were looking for in terms of using NASA products in incorporating it into the family math and science night. But, it's been somewhat easy; it just took some training time. It wasn't as easy as we'd hoped it would be" (Focus Group Interview, April 27, 2006).

The Teacher Involvement survey asked, "How much have you changed in each of the following areas as a result of being in a NASA Explorer School?" Here is a summary of the B72 teacher responses.

- Incorporate inquiry activities in your instruction? Two chose "some"; one chose "a little."
- Integrate more space science into your instruction? Three chose "quite a bit."
- Integrate more technology into your instruction? Two chose "quite a bit"; one chose "a little."
- Integrate more engineering into instruction? Two chose "a little"; one chose "not at all."
- Integrate more geography into your instruction? Two chose "some"; one chose "a little."
- Incorporate more STEM-G careers into your instruction? One chose "quite a bit"; two chose "a little."

The B72 teachers who responded to this survey point to clear advances they have made by having access to NASA professional development activities. The results show that like other schools, B72 has more difficulty incorporating engineering education. The results also show that some teachers have more difficulty integrating technology and career education than others.

B72 was one of the schools that participated in the NES-Handheld User Community study conducted by the College of Engineering at the University of

Michigan. The final report from this research showed that: "The students of the [B72] thought highly of the handhelds when looking at their writing skills compared to other schools. The schools used the handheld to focus on writing tools. The results can be interpreted that the handheld technology should be used in various ways for th students to explore a range of functions that the handheld offers."[2]

Guideline 4. Content Knowledge.

- Each team member has undertaken to acquire new skills in a specific scientific or technology area. These have included videoconferencing, integrating technology such as Smartboards, handhelds, and digital projectors, and the use of NASA web based curricular materials. Team members will also be attending conferences throughout the year in order to acquire new ideas and knowledge for themselves others in the school community."[1]
- Staff were introduced to the GEMS Build It Kit. "The kit reinforces mathematical concepts in geometry. The training was an excellent opportunity for the B72-B staff to get familiar with the material. We recognize a great opportunity to create a family night using this kit next year as well as use in the classroom."[1]

Guideline 5. Active Learning.

- "B72A and B72B are working together to achieve and sustain NES [at both school sites.] To meet our first objective of increasing student participation and interest in math, science and technology, our team members integrated NASA materials and concepts into our current curriculum."[1] "Our major expectation, our major hope with our strategic plan was that science education could become, to improve the quality of science education in both of our elementary schools. Over the past five years, just as we've been under pressure for testing specifically in reading and writing, science has really gotten pushed off of the, off nearly every teacher's docket to the point of that it's kind of an additional add on. You do it if you've got time and teachers don't have a lot of training in also using technology. We got a lot of technology at our finger tips we've got great internet access, we've got computers, we've got handhelds, but to get them used is, all the way throughout our K-6 curriculum was really our hope. And so when we look three years down the road we hope that

[2] Source: Appendix M: NASA Explorer Schools – Handheld User Community. In NASA Explorer Schools Evaluation Brief 5: Analysis of Project Impact (NES/EB5/3-2007) retrieved from http://www.cet.edu/nes.

our school, walking into our classrooms, what we're doing would look significantly different which would then result in better learning outcomes, in not only science, but reading, writing and math as well. So we're looking for integrated applications" (Focus Group Interview, April 27, 2006).

- "Let's see, other things just, to make things happen schoolwide is, it hasn't been the most successful strategy, but at each faculty meeting, team members have been standing up and just sharing, just notes on what's happening in explorer schools, whether it's an update about an opportunity or a program that we're implementing and here's a little bit more information. Can even be just current, NASA science, you know, hey there's gonna be this launch next week you might wanna mention it as part of that kind of thing. But you know, weekly staff meetings, we've taken just two or three minutes, just to kind of keep that theme going" (Focus Group Interview, April 27, 2006).
- I mean, I can speak probably for every team member in that when we met this summer, the goals we set for ourselves were, we picked areas that we were excited about saying we wish we could do some sort of implementation with this idea in our classroom, we don't know how to do it, but we're going to use the fact that we're a NASA team member to take advantage of resources that are available, and get ourselves trained in that. So, up until, up until this year, I was the only team member that had ever used videoconferencing. Now every team member has used videoconferencing" (Focus Group Interview, April 27, 2006).

Guideline 6. Coherence.

- "Both schools have low socioeconomic status and are qualified as Title 1 dollars and have Title 1 teachers on staff. And so what we've done, we've done family math and science nights we've also made them our Title 1 family implementation nights and so that, because Title 1 is a program that is in every single classroom in the school we followed it up with making sure that all classrooms has a roles in those family math and science nights because everyone has a responsibility to Title 1 so we've got a little bit of leverage because we can say, you need to be part of this because this is what we do to support our low income students. And we get money to do that and throwing with that the opportunity for support of program. Whether it's classroom displays of science and space stuff, at the math and science night, or a teacher doing an activity with a group of students that they've done in their classroom, and they teach the parents and the kids that night. I think that's been one of our most successful strategies in terms of moving things schoolwide" (Focus Group Interview, April 27, 2006).

- "This year has been PR, folks are excited, we've had five or six good articles in the newspaper about NASA related programs that we've done in various classrooms and visits from people. That excitement has been easy, which I think is the first step in developing those other partnerships. I think we're on the way, but those don't create the partnerships. Then it's taking that publicity, knowledge, and leveraging it and say how else would you like to be involved so we've been able to make three or four good partnerships. We've got a lot of ground to go if we're going to call this sustainable and really make it part, an enduring part come three years down the road… We've teamed up with the National Wildlife Refuge, that's locally here. They're helping me with Signals of Spring, the animal migration project, so they've gotten excited about that. They've gotten involved in a couple other ecological projects that we're doing schoolwide. We've teamed up with the Islands and Oceans Center, they're helping us with some plankton studies that we're doing and Conoco Phillips helped us coming on board to support a program called School Bus to Space, which would be a partnership with the Alaska Challenger Center; they sent their staff members over to do a week of space stuff in our school with us. " (Focus Group Interview, April 27, 2006).
- "I mean, we've got our coordination we've got getting families involved we've got helping teachers integrate. I think the only and it maybe be just, I don't know you've heard a number of times, it's been the one thing that's jumping out in my mind is integrating the NASA strategic plan with the school strategic plan. I'm not sure if that incorporates in here but if those two are not one in the same, movement comes very slowly" (Focus Group Interview, April 27, 2006).

Summary of How B72 Meets Outcome 1.
Through the partnership with NES, B72 teachers were able to attend professional development workshops and learn the latest technology applications as well as inquiry-based science teaching approach. The assistance of AES and field center staff have made the schoolwide NES implementation easier. The team up with National Wildlife Refuge has helped B72 team implementing some of the NES project and has also increased the family and community involvement. B72 teams projected NES as one of the greatest assistances for the students who are underserved and families are from low socioeconomic status.

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

The B72 team purchased the following technologies with NES funding:

- Ceiling mount LCD projector; doc camera install kit for B72-B
- Document Macroview camera for B72-B (1)

- Ceiling mount LCD projector; doc camera install kit for B72-A
- Document Macroview camera for B72-A (4)
- Lego Mindstorms Robotic Kit for B72-A
- HP Scanner for B72-A
- Dukane Mobile Presentation System w/ 8755E Projector
- LCD Data/Video Projector for B72-A (2)
- DVD Players (7)
- Dell Optical Mouse (30)

Through the partnership with NES, B72 received technological tools that they otherwise would not have. For example, B72 participated in the NASA Explorer Schools – Handheld User Community study and students spent four weeks using handhelds as a educational technology tool to enhance student language arts skills—particularly writing skills.[3] The teachers are excited and cannot wait to implement them in all of the grades.

- "Our professional goals have already been implemented. We began our year with a DLN that focused on inquiry-based science instruction. We will have five STEM-G related professional development opportunities from NASA that are being taken advantage of by our staff. Our goal is to have staff who is not part of the team, but a vital part of our school community, share what they have learned and implement new and exciting STEM-G based instruction in the classroom. We also have several teachers training for the project 3-D View, as well as our quest programs working with scientists to improve and expand their knowledge for the reduced gravity project."[1]
- "We will be utilizing a variety of technology such as handhelds, interactive websites, smartboards, videoconferencing, and data loggers. We also hope to utilize a number of the inquiry based GEMS units to give our students better opportunity to explore and complete real scientific experiments."[1]
- "Each team member has undertaken to acquire new skills in a specific scientific or technology area. These have included videoconferencing, integrating technology such as smart boards, handhelds, and digital projectors, and the use of NASA web based curricular materials."[1]
- "We got a lot of technology at our finger tips we've got great internet access, we've got computers, we've got hand-helds, but to get them used

[3] Source: Appendix M: NASA Explorer Schools – Handheld User Community. In NASA Explorer Schools Evaluation Brief 5: Analysis of Project Impact (NES/EB5/3-2007) retrieved from http://www.cet.edu/nes.

is, all the way throughout our K-6 curriculum was really our hope" (Focus Group Interview, April 27, 2006).

- "In my classroom, we're using hand-held computers that really haven't been implemented before and now we're using them almost on a daily basis. We've had other teachers implement video conferences using the Distance Learning Network with NASA. We've had teachers implement a Challenger Center Distance Ed. Module, the Moon, Mars and Beyond, which is something she'd never attempted before. We had another teacher working all year on learning how to implement a SmartBoard in her classroom. So how to use that new technology, and the administrator's really focused on out at B72-A having a regular set of family math and science nights that I think they've just had their fourth one so I think that's been real successful" (Focus Group Interview, April 27, 2006).
- "One challenge was, part of our plan was looking to implement things we would purchase with our technology dollars and since those haven't been released yet and we haven't been able to make any purchases none of that new technology has been implemented at all because we don't have it" (Focus Group Interview, April 27, 2006).
- "Those [handhelds] were something I'd purchased with a separate grant two years ago. I got a Toyota Tapestry Grant and some, and a donation from a local sports/fishing association so, that's something we came in with and then the explorer schools gave us the access to Elliott Soloway's software up at the University of Michigan, the High C software, and so we've started implementing that. He calls it Pam, P.A.A.M. and so we're using that software which is a very expensive software suite that we we're given access to for free because we're a NASA Explorer School" (Focus Group Interview, April 27, 2006).
- "Until this year, I was the only team member that had ever used video conferencing. Now every team member has used video conferencing" (Focus Group Interview, April 27, 2006).
- B72-1 and B72-B already had videoconferencing equipment. "Yeah, access to lots of technology, but very little training to use it. It's kind of just the money goes into the purchase of it, and then it ends up sitting. And so, a lot of us recognizes this and said, boy, this is the opportunity to learn how to use this stuff" (Focus Group Interview, April 27, 2006).
- "…so personally teachers have learned to use SmartBoards, teachers have learned to use video conferencing. I've learned how to use the handhelds and that has been great" (Focus Group Interview, April 27, 2006).
- Two B72-A teachers attended a Technology Immersion Workshop. "Teachers learned how to use a variety of technology tools such as handhelds, video recording, robotics kits, and video editing programs.

They designed inquiry lessons to share and take back to their home schools."[1]

- "Students observed layers and crystal plates of the earth. They then explored 3-D animations and the earth's plate boundaries as they related to volcanic formation. Mappings of the ring of fire in relation to our state of Alaska. This is one of many lessons in the 3-D project. Training on this was done via computer and teleconference. It consisted of 4 one hour sessions."[1]

The NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate more inclusive picture of how B72 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "20-40 times (weekly)" a year. Teachers also responded only "6-15 times" for using NASA materials in their classroom in a year.

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

Searching for postings about B72 outreach and family events on the web, we found the following comments from parents of B72-A students. The overall parent feeling positive and appreciate of the standards set for the B72-A community.[4] Parent comments were not available from B72-B parents.

B72-A
"I am pleased with the staff that they have had over the last two academic school years. The principal there is kind, interested and involved in what is going on in their school. I have had one child attend from grade K-6, another from K - 5th; K-4 and one just starting Kindergarten and couldn't be more happy with results thus far" (August 2004).

B72-A
I've had three children go to B72-A and one of them went through 6th grade the other two went through 4th and 6th grade and now living in another state I can tell you that you are very fortunate to have the staff you have at B72-A" (February 2004).

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[4] The Great Schools website lists overall positive comments from parents of B72-A and B72-B students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 22, 2007 from http://www.greatschools.net/).

Below are some of the entries that we found documenting NES B72's plan for using NASA resources to promote family involvement.

- "We will have regular family nights, with the focus on allowing parents and children to interact on STEM-G topics."[1]
- "… at B72-A, they have a regular set of family math and science nights that I think they've just had their fourth one so I think that's been real successful" (Focus Group Interview, April 27, 2006).
- "Both schools are low economic status so we qualify for Title 1 dollars and have Title 1 teachers on staff. And so what we've done, we've done family math and science nights we've also made them our Title 1 family implementation nights and so that, because Title 1 is a program that is in every single classroom in the school we followed it up with making sure that all classrooms has a roles in those family math and science nights because everyone has a responsibility to Title 1 so we've got a little bit of leverage because we can say, you need to be part this because this is what we're doing to support our low income students and we get money to do that and throwing with that the opportunity for support of programs and basically what's that's been is, whether it's classroom displays of science and space stuff at the math and science night or a teacher doing an activity with a group of students that they've done in their classroom and then they teach the parents and the kids that night. I think that's been one of our most successful strategies in terms of moving things schoolwide" (Focus Group Interview, April 27, 2006).
- "We've done, at those family nights, we not only take attendance is just getting folks there I think is a good measure family involvement. We've also done surveys of parents and interest surveys and things like that and so that information for one just in terms of attitude with plan to continue to document over the next three years and hopefully we'll A. show a much broader awareness and much broader interest of kids and parents being involved in math and science careers" (Focus Group Interview, April 27, 2006).
- B72-B "Family night was open to all of our community members. The school goal was to provide a NASA update to our community, as well as introduce them to the inquiry based process. Our PTA provided dinner which was followed by a short presentation by [our NASA education specialist] and the [school principal],
  Next was the family assembly of Rocket Racers, an inquiry based activity which was introduced to [the school principal] at the most recent NASA conference she attended. The activity was introduced to her by [AES], and was from the NASA publication; Rockets: An Educators Guide with Activities in Math, Science, and Engineering. Families worked together to create Rocket Racers. They were supplied with Styrofoam wheels and

bodies, a balloon, a straw, a wooden skewer, and 4 stick pins. From this they created their racers. Tracks measured in centimeters were set up, and used for final measurement and testing and refining. NASA backpacks filled with a variety of NASA prizes were awarded to the top two winners. The night was a great success."[1]

- The goal for B72-A's Science Night was to " educate and inform families of the upcoming shuttle flight with local hero, Billy Ophelein as pilot of the STS-116. Families will also be involved in two science inquiry projects."[1]
- Staff was introduced to the GEMS Build It Kit. "The kit reinforces mathematical concepts in geometry. The training was an excellent opportunity for the B72-B Staff to get familiar with the math Build It Kit. We recognize a great opportunity to create a family night using this kit next year as well as use in the Classroom."[1]

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

The B72 contributions to the NASA Explorer School Digital Portfolios shows that B72 has planned out several activities that emphasize increasing students' interest and participation in science, technology, engineering, mathematics, and geography. In this section of the case study we look for evidence that students are engaged in STEM-G related inquiry activities.

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 will engage in an inquiry lesson to help them discover the insulating effects of fat and fur in the Arctic region. Students are given a baggie as a mitt. They submerge their hand into some snow and water recording total time they can keep their hands in the water. Following the above step, students will explore various materials with which to insulate their baggies. They will continue until they find a combination that will keep them warm."[1]
- B72 students designed an aircraft using the five steps of engineering process. "Students task was to first become familiar with flight by designing an aircraft online through the NASA's future flight website. Following the familiarization process students where given their challenge which was to design a paper model that could carry the maximum amount of cargo at least 10 meters. Students examined criteria and constraints, generated ideas and chose the solution that best meets the

criteria and constraints. They then tested and refined their models, and presented the results."[1]

- "Students were told that NASA had sent a probe into space. The probe landed on an unknown planet and collected samples from its surface. Now it was time for the "scientists" in the room to make inferences about the history of the planet. Working in teams, each group got a bag of space material, hand lenses, tweezers and magnets. Using paper and pencil, they discussed and wrote down their findings. At the end of the session all groups shared their information with the entire class. I classified it as students instructed."[1]
- "Students observed layers and crystal plates of the earth. They then explored 3-D animations and the earth's plate boundaries as they related to volcanic formation. Mappings of the ring of fire in relation to our state of Alaska. This is one of many lessons in the 3-D project. Training on this was done via computer and teleconference. It consisted of 4 one hour sessions."[1]
- "The students first learned about the basic principles of flight, then collaborated in small groups to design a glider and built on a shoebox base that would fly. They learned that the Space Shuttle Glide/Slope Ratio is 1:1, so their goal was to build a glider that exceeded that ratio. First, students needed to learn about ratios in general, and needed to learn about the glide/slope ratio specifically (the relationship between the height the glider was launched to the distance it traveled). They also studied the aspect ratio (width of wing to length of wing). The measurements we took tied in directly with our measurements standards, and the ratios, although not required in 5th grade, directly related to fractions standards. The class videoconferenced with a NASA scientist, learning the fundamentals of flight and the requirements of their DLN activity. They then launched into two months of research and experimentation, followed by their glider flight trials and data recording and analysis. Following their final flights and data analyses, they reported their findings to their NASA scientist and proudly displayed their gliders by videoconference."[1]

Noticeable curiosity in STEM-G topics and events

- "Students at B72-A have participated in a variety of activities in preparation for the launch of the STS-116. Activities included classroom research projects focused on different facets of the preparation for the launch. A "good luck" banner was created and signed by students and then sent to Billy O. The month long activities culminated in taking 100 students by bus the [B72] Challenger Center. Along with approximately

200 other [city] residents (including the city and borough mayors), the students took part in watching the preparation of the launch (which, unfortunately was aborted and rescheduled), and other activities at the center. The exposure to the "mission control center" and space shuttle as well as the StarDome and constellation discussion made this an event that students will remember for a lifetime."[1]

Attitude changes about learning

One of the data sources used to assess student attitude changes about learning is an interest survey that NES schools were asked to complete in the fall and spring of the 2005-2006 academic year. B72 scores on the NES student interest posttest were average, and did not exceed the mean score across all schools.

Teachers at B72 observed changes in student behavior when performing NASA activities.

- "Students were highly motivated and focused while working on this challenge. I would spend more time having students set up their data logs efficiently, and allow more time for student suggestions (and related recording of those suggestions) and modification responses. The teams tended to each work independently, and while that worked well, more cross-team feedback would have been helpful."[1]
- "The students first learned about the basic principles of flight, then collaborated in small groups to design a glider, built on a shoebox base that would fly. They learned that the Space Shuttle Glide/Slope Ratio is 1:1, so their goal was to build a glider that exceeded that ratio. First, students needed to learn about ratios in general, and needed to learn about the glide/slope ratio specifically (the relationship between the height the glider was launched to the distance it traveled). They also studied the aspect ratio (width of wing to length of wing). The measurements we took tied in directly with our measurements standards, and the ratios, although not required in 5th grade, related directly to fractions standards. The class videoconferenced with a NASA scientist, learning the fundamentals of flight and the requirements of their DLN activity. They then launched into two months of research and experimentation, followed by their glider flight trials and data recording and analysis. Following their final flights and data analyses, they reported their findings to their NASA scientist and proudly displayed their gliders by videoconference."[1]

Active participation in hands-on and authentic scientific research

- As a NASA Explorer School, [B71-A] 6th grade Quest students were recently able to send an experiment into space through a rocket launch program called LaunchQuest! Flying into space on LaunchQuest's second

rocket launch, which blasted off from New Mexico's Spaceport America on April 28th, were dozens of student experiments from elementary schools to high schools to universities. LaunchQuest experiments were placed into small pie-shaped containers and then loaded aboard the rocket in various payload compartments. Students will analyze the returned material to see whether exposure to microgravity space flight had any noticeable affect on the materials effectiveness."[1]

Outcome 5. Increased student knowledge about careers in STEM-G.

B72 teachers observed students' self-identity change after visiting with real astronauts. Students become more familiar with types of careers in NASA and aware of what it takes to get there. There is a place for them in NASA.

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

Change in self-identity

- "… when they're able to look at an astronaut and the astronaut talks to them and says, you know, you listen [a CFO] say, you know, I'm the person who writes the check and I'd like to be writing a check for you, working for me someday. That is tremendous" (Focus Group Interview, April 27, 2006).

Increase understanding and enthusiasm about STEM-G careers

- "Our specific goal for our students increase in knowledge about careers is to provide interaction and opportunities with a variety of individuals throughout the community that are currently involved in technological and science related careers. We will do this through field-trips, classroom speakers, and through the utilization of the video conferencing equipment and the DLN."[1]
- "We will bring in guest speakers to give presentations focusing on opportunities for young people in areas related to STEM-G careers. In order to raise general awareness of NES, we created and distributed informational brochures, conducted radio and newspaper interviews, and will talk up the program throughout the communities. We will seek to involve community organizations and businesses in the NES program."[1]

Share information with their peers and parents

- B72 students designed an aircraft using the five steps of the engineering process. "Students task was to first become familiar with flight by

designing an aircraft online through the NASA's future flight website. Following the familiarization process students where given their challenge which was to design a paper model that could carry the maximum amount of cargo at least 10 meters. Students examined criteria and constraints, generated ideas and chose the solution that best meets the criteria and constraints. They then tested and refined their models, and presented the results."[1]

- "Students were told that NASA had sent a probe into space. The probe landed on an unknown planet and collected samples from its surface. Now it was time for the "scientists" in the room to make inferences about the history of the planet. Working in teams, each group got a bag of space material, hand lenses, tweezers and magnets. Using paper and pencil, they discussed and wrote down their findings. At the end of the session, all groups shared their information with the entire class. I classified it as students instructed."[1]
- "The students first learned about the basic principles of flight, then collaborated in small groups to design a glider, built on a shoebox base that would fly. They learned that the Space Shuttle Glide/Slope Ratio is 1:1, so their goal was to build a glider that exceeded that ratio. First, students needed to learn about ratios in general, and needed to learn about the glide/slope ratio specifically (the relationship between the height the glider was launched to the distance it traveled). They also studied the aspect ratio (width of wing to length of wing). The measurements we took tied in directly with our measurements standards, and the ratios, although not required in 5th grade, related directly to fractions standards. The class videoconferenced with a NASA scientist, learning the fundamentals of flight and the requirements of their DLN activity. They then launched into two months of research and experimentation, followed by their glider flight trials and data recording and analysis. Following their final flights and data analyses, they reported their findings to their NASA scientist and proudly displayed their gliders by videoconference."[1]

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

Documented in the e-Folio, teachers utilized the DLN to promote science learning. Students are also actively participating in the STEM-G competitions that allow students to apply STEM-G knowledge and skills to solve real-world problems.

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

- "We will provid[e] our students with the opportunity to participate in a number of STEM-G competitions including Geo Bee, NASA Quests, Design Competitions, Exploravision, and student payload design competitions."[1]
- Through the DLN WORF Imaging activity "Students will be able to define geography and how geographers use it to answer questions about physical and human interactions, be able to use interpretive skills to identify observable characteristics that provide new insights and understandings about the physical and human aspects of our planet, and be able to compare changes between two images from the same location at different time periods and predict future outcomes."[1]

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

- "It's [High C software for handhelds] been one of the most exciting things I've had to play with all year. The kids are excited about it. My big concern long term with it is if I don't have funding to use that software, literally, management of the hand-helds, the time would go up probably 20 or 30 time to manage them. It's that good of a software suite."[1]

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

B72-A did not make AYP in 2004-2005, but has not been identified as in need of improvement for 2005-2006. B72-B met adequate yearly progress (AYP) in 2004-2005 and was not identified as in need of improvement for 2005-2006. Tables 5 through 12 listed the Standards Based Assessment (SBA) scores for grades 3 through 6 for each school.

- "The other thing we're watching is specifically our math scores. Schoolwide one of our weakest areas is just our math skills in general. We tend to be as a school, not significantly, but below national norms and below where we'd like to be. And so, when we look at direct measurably nationally normed measurements on would be our math test scores. We just took our national tests just last week and so that's clearly a target goal there. That's honestly led to some of the conflict with direction for the school is team members are saying, hey the way to do this is through the NASA Explorer Schools and our administrator says, no the way we're going to do this is through curriculum mapping and looking at our schoolwide curriculum and making sure that our math sequence is

correct. I think they're both good answers. I think there's room for both...Does that make sense?" (Focus Group Interview, April 27, 2006).

Table 1-A. B72-A School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	181	201	393	
Black, non-Hispanic	1	2	3	
Asian	4	0	15	
Hispanic	4	1	7	
Indian, Alaskan Native	33	24	70	
White, non-Hispanic	139	174	298	
School location (rural, suburban, urban, mid-size central city)	Rural, outside CBSA/MSA	Rural, outside CBSA/MSA	Rural, outside CBSA/MSA	
School type (public, private, charter, magnet)	Public	Public	Public	
Title 1 status (yes or no)	Yes		Yes	
Free and reduced price lunch	65%		44%	

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 17, 2007 from http://nces.ed.gov/ccd/bat/

Table 1-B. B72-B School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population		208	201	
Black, non-Hispanic		1	2	
Asian		1	0	
Hispanic		3	1	
Indian, Alaskan Native		18	24	
White, non-Hispanic		185	174	
School location (rural, suburban, urban, mid-size central city)		Rural, outside CBSA/MSA	Rural, outside CBSA/MSA	
School type (public, private, charter, magnet)		Public	Public	
Title 1 status (yes or no)		Yes	Yes	
Free and reduced price lunch		45%	52%	

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 17, 2007 from http://nces.ed.gov/ccd/bat/

Table 2. Summary of Academic Needs Identified by B72 in 2005

Priority	Discipline	Category	National Standard
1	Principles and Standards for School Mathematics	Algebra	Use mathematical models to represent and understand quantitative relationships
2	National Science Education Standards	Life Science	Populations and ecosystems
3	National Science Education Standards	Physical Science	Properties and changes of properties in matter
4	National Geography Standards	Environment and society	How physical systems affect human systems
5	National Educational Technology Standards		Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
6	Principles and Standards for School Mathematics	Connections	Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
7	National Science Education Standards	Earth and Space Science	Objects in the sky
8	National Science Education Standards	Life Science	Structure and function in living systems
9	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the characteristics and scope of technology
10	National Science Education Standards	Physical Science	Light, heat, electricity and magnetism

Source: B-72 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that B72 Teachers Completed

Summer orientation workshop at Field Center B Research Center
2006 Technology Immersion Workshop
2006 NASA Leadership Academy
2006 NSTA Conference -Arctic weather and safety/NES-Fragile Ice Symposium
2007 NSTA (Salt Lake City, UT)
GEMS Training

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That B72 Teachers Incorporated into Their Instruction

NES Funding
AES Contacts
NASA Connect
DLN
ISS EarthKam
NASA Quest
GEMS
Future Flight Design and website http://futureflight.arc.nasa.gov/designs
NASA CD: NASA Explorer Schools, Pathway to the Stars
Rockets, An Educators Guide with Activities in Science, Math, and Technology
eMission: Moon, Mars, and Beyond
Websites: www.grc.naasa.gov/WWW/k-12/airplane/bgk.html http://nasaexplores.com
WORF Images Library
Website: http://www.dfrc.nasa.gov/Education/index.html
FIELD CENTER B Research Center NASA scientists
Website: http://www.launchquest.org/

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. B72-A SBA Grade 3 Scores

	Reading	Writing	Math
2005	88%	77%	70%
2006	87%	81%	83%
State Average in 2006	79%	75%	76%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 6. B72-A SBA Grade 4 Scores

	Reading	Writing	Math
2005	80%	74%	55%
2006	91%	89%	67%
State Average in 2006	79%	80%	73%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 7. B72-A SBA Grade 5 Scores

	Reading	Writing	Math
2005	76%	62%	51%
2006	83%	79%	68%
State Average in 2006	79%	77%	70%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 8. B72-A SBA Grade 6 Scores

	Reading	Writing	Math
2005	86%	66%	66%
2006	77%	69%	59%
State Average in 2006	76%	72%	67%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 9. B72-B SBA Grade 3 Scores

	Reading	Writing	Math
2005		73%	73%
2006	64%	61%	55%
State Average in 2006	79%	75%	76%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 10. B72-B SBA Grade 4 Scores

	Reading	Writing	Math
2005	91%	85%	64%
2006	94%	82%	76%
State Average in 2006	79%	80%	73%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 11. B72-B SBA Grade 5 Scores

	Reading	Writing	Math
2005	91%	85%	58%
2006	100%	92%	92%
State Average in 2006	79%	77%	70%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

Table 12. B72-B SBA Grade 6 Scores

	Reading	Writing	Math
2005	88%	81%	81%
2006	83%	79%	72%
State Average in 2006	76%	72%	67%

*Source: SBA Results. (2005-2006). Alaska Dept. of Education. Downloaded 05-22-2007 from http://www.eed.state.ak.us/

NASA Explorer Schools Case Study Profile: C14
2005 Cohort—Urban, Indiana, Public Elementary School: Grades PK-6

Summary Comments Regarding C14
C14 is public elementary school located in the urban fringe of a mid-size city although the C14 team described their location as rural. The school district is small and the K-12 schools (elementary, middle, and high) are physically located next to one another. The student population increased from 733 to 758 from 2003-2004 to 2004-2005. The student population is predominantly white (almost 100%) with 39% of the students qualifying for free or reduced lunch. Since the year of 2002, the school has been listed as Title 1 School. Additional demographic details are provided in Table 1.

Here are some of the successes that C14 achieved during its three-year period as a NASA Explorer School:

- The NES coordinator identified C14 as a successful school citing schoolwide involvement in NES, use of DLN, use of AES for professional development and students, non-NES grants, and regular communication with the NES coordinator as contributing factors for C14's success (Field Center Staff Report, 2006).
- C14 made professional development opportunities available to all of their staff, even extending beyond the elementary school staff to include their junior high building.
- C14 found an innovative use for the distance learning equipment purchased with their NASA grant. They were able to help a student who broke his femur bone by connecting the classroom to the student's home. This use of videoconferencing equipment encouraged teachers to become familiar with using the distance learning equipment they appear to be more comfortable using it.

As a school that serves a predominantly poor population C14 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- The C14 team cites lack of time as a challenge. However, they seem to overcome this challenge by willingly doing most of the NES planning outside of school hours.

We examined schoolwide achievements at C14 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 transcript of a focus group interview conducted by telephone with the C14 NES team on May

10, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES C14 team was formed in 2005 with five members including the team lead who is the elementary school principal (he also teaches every day but always in the same grade), the team administrator who is the school professional development director, a third grade teacher, and an elementary teacher. The original fifth team member was a high school chemistry teacher, but she withdrew from the team for maternity leave. The teacher chosen to replace her also resigned and as of the spring 2006 interview, the position remains vacant. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation C14 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 NASA Camp, GPS activities, and Family Night. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that C14 has taken advantage of as a NASA Explorer School.

The next section examined the extent to which the C14 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

- "From the very beginning I was excited about it because I always loved science but never really had a strong confidence about it. And so the biggest thing for me is participating in the week-long training at Cleveland. [The training] really boosted my confidence and even thought it was challenging sometimes I realized that I needed to get over my, whatever fears I had, whatever intimidations I had about teaching science because you don't have to know all the answers. One of the best things I remember about being at the workshop was even some of the brightest engineers would say we don't have the answers and we know we never will but we have the methods and resources to help us find the answers and we may never get to the final answer but we're finding answers every day. And that just really stuck me as one of the things I do as a teacher. I'm not there to give them the answers. I'm not there to even help find all the answers. I'm there to help them find a way to find the answers. And so to me that's just, that resonates in my head that I have to keep my feet on

the ground and realize we're all learning all the time" (Focus Group Interview, May 10, 2006).

In addition to our analyses from case study, we report some key findings from the survey data on C14. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, one teacher said "1-3 times per month," the other said "1-3 times per week" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or task, one teacher said "always everyday," and the other said "1-3 times per week" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often they accomplish the following goals:
    - Elicit students' ideas and opinions: One teacher said "very often," and the other said "always."
    - Get students to justify and explain their reasoning: Both teachers said "very often."
    - Have students relate what they are working on to their own experience: One teacher said "often," and the other said "very often."
- Two teachers completed the Teacher Need and Involvement survey. In responding to how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, one teacher said "some," and the other said "quite a bit."

Guideline 2. Time Intensive.

- "Our full staff will connect with [field center representative] from Field Center C to discuss the benefits of videoconferencing."[1]
- "…with the professional development part for the teachers, this year we were just trying to share with the teachers all the possible places they could go to get these new resources that we weren't used to having and that was a big challenge for us because there's just so many. And for people actually getting, to find the time to look through all of them it's pretty tough" (Focus Group Interview, May 10, 2006).
- C14 made the professional development training with the AES available to everyone on staff. Every grade level met at least once with the AES.

[1] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007 from http://aesp.nasa.okstate.edu/efolio

Even their junior high building took advantage of some of the national conferences that were offered to C14. Specifically, the team stated, "We had some people go to some national conferences and also to we had [AES]. She's been here a few times to work with teachers on certain things. So yeah, we've had a pretty good opportunity so far this year for professional development" (Focus Group Interview, May 10, 2006).

- "The other challenge is if you didn't get to go to the [field center] for the training…because [at the training you] spend a week with all these people [who] share all this great things with you and…[you]…share that back with the staff so they are as excited and pumped up about it as you are. … not getting to go and experience that…was tough. But what we did was, you know, we kept talking it up, talking about it, letting people know about the resources, being that support system.." (Focus Group Interview, May 10, 2006).
- "Like I said, the resources are just so many. You know, when you get a meal ticket trip to Yosemite to study the water cycle and you send that out a lot of people are like you know are you kidding me? You know they are going to pay for this and actually let me go to this and explore this? You know it's almost not real for some people" (Focus Group Interview, May 10, 2006).
- "[The Mars Aeronautical Educational School specialist [our program coordinator]… They helped us out a lot with grants. We wrote a grant and they helped us out with making sure the wording was right for that. They've provided us resources. They've done talks with us. They were just here today working with teachers that were going to be teaching summer school and making sure their curriculum was in line and providing new resources and ideas and opportunities. So all that's been working out really good. Also we worked with [distance learning representative] …but he is the distance learning guy and he helped me with…the bid on the equipment and what type of equipment I should look for and who I needed to talk to and all those types of things for the distance learning equipment" (Focus Group Interview, May 10, 2006).
- "Personally it's been an excellent opportunity for me just for the fact that I've gone to national conference. I got to talk to some of the best principals in the U.S. about what they're doing to get better at their elementary schools. And a lot of what I've learned there is not necessarily about STEM-G, it's about reading and student behaviors and things like that. I got to, I never visited Texas so I've got to go to Texas twice now through NASA. It's been a real neat opportunity and like (the other teacher) sort of mentioned too, I wasn't a real big fan of space science, but after this opportunity I'm a lot bigger fan and I'm more interested and now I can share that sort of passion and ideas about science and space with kids here from C14 that probably, cause I grew up around here too, that wasn't real

interested because it never seemed like something you could grab and something you could actually do grown up, where we grow up at, where we've grown up at" (Focus Group Interview, May 10, 2006).

Guideline 3. Classroom Practices.

- "Our full staff will connect with [distance learning representative] from [Field Center C] to discuss the benefits of videoconferencing."1
- "To educate, my perception is to educate the future for NASA basically in science, engineering, technology and geography. And to make that as hands-on and to build kids' interest in those areas so NASA can fulfill their missions they are working on in the future" (Focus Group Interview, May 10, 2006).
- "I think that one of the things that we as a team have learned is to start simple and provide opportunities to build excitement. I know in my own students, I have three or four of course who are just sure they're going to be the first one, you know, why not, somebody's going to do it. And I think planting that seed of, of, that they do have the abilities and that now that, it's almost like I think other teachers shared my intimidation a little bit of science and how to teach it. I think that we were satisfied with sticking to our textbooks thinking well if it's in the textbook it must be valuable. If it's in the standards that's what we have to teach and now we're kind of stepping out of our little boxes and realizing we don't have to know everything. Science is just a natural curiosity builder and I think that a direct effect of the teachers being able to be a little bit more confident in teaching science has had a domino effect on the students that they're now asking more questions. They want to know more. And for me personally, I just think that the fact that my kids look forward to science speaks volumes. I know that when I was a kid most people regarded science as, oh, that boring forty-five minute period of the day. I guarantee you my kids don't think of it that way and it's not because of anything, it's not because of my way of teaching or anything. I think it's because I'm excited about it and when the kids see that you're excited about it and what you can do with it that it opens up your world. They can't help but be excited about it" (Focus Group Interview, May 10, 2006).
- "Another thing we offered to the students too is this futuristic thing. This summer we are going to be offering a NASA Explorer School summer camp for a week. And we are going to be doing rocketry, robotics, life on the moon. And then we're also going to be doing some challenges in our computer lab" (Focus Group Interview, May 10, 2006).

Guideline 4. Content Knowledge.

- "Well we've met, we meet at different times and we talk about our NASA nights and upcoming events for the next year. We've got a big NASA

Explorer camp we're planning now for the summer we're real excited about. So the NASA team members, we bump ideas off each other all the time and talk about how we can, you know, incorporate the STEM-G into our camp" (Focus Group Interview, May 10, 2006).

Guideline 5. Active Learning.

These excerpts from the profile of C14 on the NASA Explorer School Digital Portfolios website provides the team's vision as to how they plan to connect their NES activities to their school's academic goals."[1]

- The goals created to meet the NES program objective will be focused upon the development of NASA/NES resources, whole school events, and class and student projects. These goals are long-term, and many will meet more than one NES program objective listed on the action plan. We have created an authentic integrated plan of action for our school that will truly benefit all.
- Our primary goal for the first objective is to integrate NASA resources into our school's existing curriculum. During the first year of the program, the team will use multiple opportunities to learn about different NASA resources available and how to integrate them into our existing state standards. Additionally, we will use the expertise of the aerospace education specialist assigned to our school as well as other personnel at NASA.
- Our goal for the second NES objective involves the use of mentoring, video streaming, guest speakers, and field trips to local universities in order to increase student knowledge about careers in science, and/or mathematics, and/or technology.
- Our goal for the third NES program objective is to increase students' ability to apply science, technology, engineering, math, and geography (STEM-G) concepts by completing many activities including microgravity experiments, GPS challenges, and by creating a schoolwide science fair.
- Our goal for the fourth NES objective is to provide professional development opportunities (via NES AES personnel, NASA resources, and other providers) to introduce or reinforce the practice of inquiry-based instruction among K-12 teachers. Also, to garner effective communication and ensure the needs of the students are being met, the NES team will meet at least once every three weeks.

This excerpt from the focus group interview shows how the C14 team have implemented a schedule for regular team meetings and curriculum planning sessions:

- "We meet monthly for staff meetings and the grade level teams meet quite a bit. And then we also meet with what we call grade level chairs and in

those meetings we would try to you know share the information and those but then at the same time too you know time was still an issue but really that buy-in, understanding what the program was all about, and the opportunities" (Focus Group Interview, May 10, 2006).

Guideline 6. Coherence.
C14 has established several partnerships thus far: one is with Boston Scientific and the other is with the [city]. (Focus Group Interview, May 10, 2006). C14 has also, collaborated with a local, non-NES school to share their robotics club activities. The videoconference (costing $200) was funded by NASA and a GT Grant. Below are excerpts from the C14 focus group interview and portfolio postings that highlight C14 team member educational reform and sustainability strategies.

- "Our first primary objective was to integrate NASA resources into our schools' existing curriculum. Just trying to take opportunities to learn about the NASA resources and to integrate it into our existing state standards and that was our first goal" (Focus Group Interview, May 10, 2006).
- "Well, one thing that I've noticed is sometimes Indiana state standards are pretty limited in science and so to me the biggest advantage has been taking the Indiana standards and expanding on them based on what we've been able to learn from NASA. I'll give you one example. In third grade science standards are so limited that in terms of space for example, the standards are pretty much limited to the study of the moon and moon phases. To me that just wasn't enough, so we were able to use lots of NASA resources in third grade to build upon and enrich that curriculum so that they are not just getting what's required by Indiana but way more than that" (Focus Group Interview, May 10, 2006).
- "We've had one member, actually she was a high school chemistry teacher, cause we're trying to provide this experience to K-12. We're a small school district and all three buildings are right beside each other. And so to get buy-in from the high school we put her on our team. The only reason that she stepped off the team is that she's had a baby and the time commitment just wasn't possible for her" (Focus Group Interview, May 10, 2006).
- "We've been working with [Boston] Scientific. It's a company that's been helping us out with grants and ideas and providing us resources. Of course, like I said the mayor has been real excited about our incorporation to our school being name a NASA Explorer School. We've been working with, we have a couple of [county] grant writers and they're working on National Science Foundation grant and since we're a NASA Explorer School we provide a summer camp and we also invite our kids plus [county] kids from other schools to come to our summer camp. They want

> us to be sort of the host for this grant where we'll keep offering summer opportunities for all of [county] here at our school and if we land that grant it's a 2.4 million dollar grant over three years. So, we're excited about seeing where that leads us" (Focus Group Interview, May 10, 2006).

Summary of how C14 meets outcome 1.
At this point in time, many of the C14 goals are yet to be actualized, but the digital portfolio entries thus far show that the school is laying the groundwork for these objectives. Activities such as the five-day NASA camp, family science nights, robotics activities, use of videoconferencing to bring in STEM-G experts from around the world have been implemented. It is difficult to tell to what extent these activities achieved the desired C14 academic goals from the digital portfolio descriptions. C14 team has actively sought local business partnerships with whom to build lasting relationships. For example, C14 team has been working with Boston Scientific to develop an NSF proposal for expanded funding to build on what's established with the NES program thus far.

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

The C14 team purchased the following technologies with NES funding:

- Tandberg video conference unit
- Advanced service for Tandberg 770 MXP
- Hitachi projector
- Anchor speaker system
- DaLite cart and power strip
- Installation service
- InFocus LCD projectors (3)
- Robotics Educator Software Site License
- Extension cord for Tandburg videoconferencing system
- SmartBoard and stand

C14 teachers have made use of the technologies that were purchased through NASA funding. For example, teachers incorporate a GPS system with the science club activity to help students learn to track weather change and meteorology. Students also have participated in several distance education programs where they talked to NASA scientists about career choices.

- "Another thing that we've done is we've started a very informal science club for third through sixth graders and we meet about every six weeks or so and we've discussed things such as astronomy. We've done weather and how it relates to space and specifically meteorology. And we're

getting ready to do a GPS meeting where we are actually going to meet and going out and using GPS systems to locate things and we're probably forgetting a lot of things because we're just kind of taking it for granted but just incorporating as much as we possibly can. And like Kent said, it's a little overwhelming because there's so much to choose from. So I think our biggest problem has been finding the time to really focus on what we really want to do with it" (Focus Group Interview, May 10, 2006).

- "One thing I know that with the distance learning equipment we were able to purchase from our NASA grant, we were able to use that in a variety of ways, one of which is to help a student who recently broke his femur bone and were able to […] classroom and connect with his home using the distance learning equipment and that has been a real good connection for the teachers to become familiar with using the distance learning equipment and now I think they have a much more comfortable and stronger desire to want to connect with NASA through the distance learning equipment because they are more familiar with using it and so it's not so, not so foreign to them" (Focus Group Interview, May 10, 2006).
- "Well, personally I think it helped open my eyes to the whole NASA world. And prior to this I, you know, when I think of NASA I just think of the space shuttle and now I realize that NASA is so much more. You know they have helped throughout the world in a lot of different things so they really opened my eyes to what NASA is. You know, and professionally I think I have really a lot more opportunities now. I think I would. Plus the technology and more, when I think of NASA I think about the distance learning how we can use things. So professionally there's just so many opportunities to be able to teach students about what is out there so it just kind of opened my eyes up to a lot of new things" (Focus Group Interview, May 10, 2006).
- When asked how he thought NES helped teachers at C14, he responded, "I think that just getting to use different technology, getting to know there's different ways to do things, getting to know there's a lot things that NASA does that just isn't about astronauts and the space shuttle. That there's all kinds of research that they do and there's all kinds of different jobs you do at NASA" (Focus Group Interview, May 10, 2006).

The NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate a more inclusive picture of how C14 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "11-20 times" a year. Teachers also responded only "6-15 times" for using NASA materials in their classroom in a year.

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

Searching for postings about C14 outreach and family events on the web, we found the following comment from a C14 parent.[2]

> "I absolutely love the caring teachers my kids have had but dislike the administration completely. In addition, this school does not have any programs for gifted children" (January 2007).

As documented in the e-Folio, we found that C14 has initiated several family events for parents to participate in their children's learning. Events include hands-on activities and use of real instruments. Some examples of family involvement events are as following:

- "Students and families will be invited to come and explore a variety of NASA STEM-G websites which will help to stimulate interest and gain understanding in the STEM-G areas."[1] After a brief introduction families will work in teams to create balloon powered moon rovers. Family teams will compete against one another to create a vehicle that will travel the farthest on one balloon full of air. Teams build their craft from an assortment of provided materials."[1]
- "Now of course we did want to increase parent involvement and we done that through NASA family night" (Focus Group Interview, May 10, 2006).
- "You know, a certain grade level will do an activity, they'll see the reactions of their kids and parents and will know it was accepted and that motivates them to do another one. I know that's how it was with the family night. Our first family night we've had in a long time at Linton-Stockton elementary and the people that came out for it was just unbelievable and that's pretty well pumped up that hey we're ready to do another one – you know the people that came. You know a lot of it is being supportive and being there for the teachers and you know helping them out when they can but this instant success of having a program or starting them off keeps them up and pumps them up to doing the next thing" (Focus Group Interview, May 10, 2006).
- "We send out every e-blast, every little detail about NASA that I get I send it out to every teacher. I mean they know when there are opportunities for trainings and neat projects and ideas. Every, not every meeting, but a lot of our meetings we've always tried to mention something about the NASA program and you know pump it up. And at our principal's

[2] The Great Schools website lists overall positive comments from parents of C14 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 24, 2007 from http://www.greatschools.net/).

meetings [the principal] and I share the message on to with the junior high principal, you know trying to keep him up-to-date about what's going and those types of things. Our school board meetings, we've mentioned it there before. So…Our mayor is really excited about being a NASA Explorer school and you know he came to our opening kickoff day and when he was speaking to some of our kids just the other day about the recycling the third graders were doing. He was talking about how C14's kids are best of the best because that was the theme of the big opening kickoff was how NASA chooses the best of the best to represent them and [name] sort of ran with that…a positive force" (Focus Group Interview, May 10, 2006).

- In response to being asked about how difficult it was to select NASA resources for families and students to use via whole school events, one teacher responded, "I think for me, I would have to say that the big events, the family nights, the NASA nights, where we have different activities going on. For instance, one night we showed the movie "October Sky." The big events to me were easy. To me it's more difficult to sustain that excitement. It's the little things. For instance, I'm the unofficial sponsor of the science club and I struggle to death with topics. But, but it's not because the topics aren't there. It's because I have to choose one topic every six weeks or so out of ten thousand possible topics. It's a little overwhelming to choose what should I do, what could I do, for this extra activity. So the big events were fairly easy. It's the sustainability of keeping that excitement, keeping everything interesting, and not getting covered up by having too many things going on. I think that was the difficult part" (Focus Group Interview, May 10, 2006).

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

Since NES, C14 has established an informal science club that includes all the NASA provided activities for students to participate more hands-on activities in addition to their regular curriculum. School also offers a summer camp for the kids to participate in some cool science activities. Students of C14 are more motivated than they used to and it has made the teachers' job easier.

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

- C14 offered a NASA Camp for its students where activities included a rocket launch and LEGO robotics. "Students entering grades two through six were invited to attend a five day STEM experience."[1]
- "Another thing that we've done is we've started a very informal science club for third through sixth graders and we meet about every six weeks or so and we've discussed things such as astronomy. We've done weather and how it relates to space and specifically meteorology. And we're getting ready to do a GPS meeting where we are actually going to meet and going out and using GPS systems to locate things and we're probably forgetting a lot of things because we're just kind of taking it for granted but just incorporating as much as we possibly can" (Focus Group Interview, May 10, 2006).
- "After a brief introduction families will work in teams to create balloon powered moon rovers. Family teams will compete against one another to create a vehicle that will travel the farthest on one balloon full of air. Teams build their craft from an assortment of provided materials."[1]
- "[Teacher's] 1st grade students followed [Teacher's] expedition on the Oden while studying penguins."[1] The students visited with [Teacher] via webinar to ask questions about his work on the Icebreaker Oden. "The scientific objectives of the cruise were to collect a range of data in rarely traveled areas of the Antarctic seas and coastline, including the Bellingshausen, Amundsen, and eastern Ross Seas. International science teams worked alongside teachers and other personnel monitoring wildlife, including pinnipeds, cetaceans, seabirds, and penguins; surveying sea ice and meteorological conditions; mapping the chemical, thermal and bathymetric properties of the ocean; and measuring the abundance of plankton and nutrients in the ocean. These studies will add to our limited knowledge of these remote corners of the Antarctic and allow future researchers to expand their monitoring efforts in these regions.[3]
- "Another thing we offered to the students too, you know it's a futuristic thing, this summer we are going to be offering a NASA Explorer School summer camp for a week. And we are going to be doing rocketry, robotics, life on the moon. And then we're also going to be doing some challenges in our computer lab" (Focus Group Interview, May 10, 2006).

Noticeable curiosity in STEM-G topics and events

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[3] International Expedition to Antarctica aboard the Icebreaker Oden. (2006). Polar Trec (Teachers and Researchers Exploring & Collaborating). Retrieved May 24, 2007 from http://www.polartrec.com/oden-expedition/overview

- "One thing I want to mention about the students their changes. We had another program we didn't tell you about. We had a young eagles program where kids got to fly airplanes and a lot of our kids who got to do that it's the first time they've ever flown in an airplane. And that was real changing for those kids who never seen the Earth from above the clouds. And so, not a lot of kids took advantage of that but probably close to thirty. And I see us doing that again next year, and I know a lot more kids will take, will take that opportunity after hearing what they got to experience" (Focus Group Interview, May 10, 2006).

Changes in self-concept

- "Our mayor is really excited about being a NASA Explorer school and you know he came to our opening kickoff day and when he was speaking to some of our kids just the other day about the recycling the third graders were doing. He was talking about how C14's kids are best of the best because that was the theme of the big opening kickoff was how NASA chooses the best of the best to represent them and [name] sort of ran with that…a positive force" (Focus Group Interview, May 10, 2006).

Attitude changes about learning

- "Of course the program helped me to do my job because it motivated kids. And any time I can get kids motivated my job gets easier. Because if they're motivated and they're fired up about being here then that makes my job a lot easier so that worked out real well" (Focus Group Interview, May 10, 2006).
- "I've heard different teachers say the fact, that just the pride, that they teacher at a NASA Explorer School. And you can see that, just that feeling, you know that I work at a NASA Explorer School. So personally, that is a very positive thing and kind of a feather in your cap so to speak. So that's nice to have" (Focus Group Interview, May 10, 2006).

Outcome 5. Increased student knowledge about careers in STEM-G.

Students are excited about the things that they can do for their future. Letting students become aware of possible opportunities in NASA is one of the important goals of NES. Teachers talked to kids about careers in STEM-G more than ever.

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

- The C14 team hopes to broaden their students' views and expectations. "We expect opportunities for our students to learn about other professions. We're in a rural community so a lot of times we don't think outside of our little community here and we wanted to let kids know that there are, were other opportunities out there for them" (Focus Group Interview, May 10, 2006).
- A C14 teacher talking about her expectations of the NES program stated, "…the only thing that I think I can add is just that especially since I teach the lower levels to promote and build a love and appreciation for science. I think sometimes it can seem really intimidating and I think we need to go back to the understanding that it is, can be, so very enjoyable and that someone can make a living at it" (Focus Group Interview, May 10, 2006).
- When asked what he/she wanted to achieve for his/her school, the principal replied, "…just to let children know that there's, that there's opportunities out there for them and kids just like them that come from small towns can do big things. And then, and then also give them an opportunity to meet and talk and discuss with people that are doing those types of jobs right now" (Focus Group Interview, May 10, 2006).
- "I know I've talked to a lot of parents and, at different times, and they said now my child comes home and tells me they want to work for NASA. I, you know, we had one of our big kickoffs. Before, I would have, kind of thought that if you worked for NASA you were an astronaut. But now we realize you could, you could do anything for NASA. NASA has all types of jobs and so that really opened up, I use this phrase again, it really opened up their eyes, our students to, hey, I could really work at NASA someday. I don't have to be an astronaut. NASA does all different types of things. So, it gave them some hope, you know, and hey I could do something neat like that. A lot of kids who got that experience were able to envision themselves as working for NASA someday. So it's a kind of like create an excitement for them" (Focus Group Interview, May 10, 2006).

Increase understanding and enthusiasm about STEM-G careers

- "Well, we've had kids for the first time really understanding what NASA is to start off with and then, and then Marge just came and did some presentations for our students about opportunities and careers and you know what people do at NASA" (Focus Group Interview, May 10, 2006).
- When asked how he thought NES helped teachers at C14, he responded, "I think that just getting to use different technology, getting to know there's different ways to do things, getting to know there's a lot things that NASA does that just isn't about astronauts and the space shuttle. That there's all kinds of research that they do and there's all kinds of different jobs you do at NASA" (Focus Group Interview, May 10, 2006).

Share information with their peers and parents

- "Some of our 5th grade students will talk with junior high students from [sister NES school] about their Lego Robotics club. These students will illustrate what they have accomplished so far with their robots."[1]

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

While striving to improve their standardized testing scores, teachers face the challenges of implementing NASA resources to match state standards. There are some obstacles in terms of what resources should be used to improve students' scores.

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

- C14 did not meet adequate yearly progress (AYP) in 2004-2005, but was not identified as in need of improvement for 2005-2006. Tables 5 through 8 list the Indiana Statewide Testing for Educational Progress-Plus (ISTEP+) scores for grades 3 through 6. In 2007, C14 exceeded the state average language arts achievement scores in grades 3 and 6, and in mathematics achievement scores for grades 3 and 5.
- When asked if there was evidence of the impact of the NES program on C14 students, the principal responded, "Not necessarily. Not officially. So that would be a no. But I can just tell you from talking with kids and teachers and parents there has been an impact" (Focus Group Interview, May 10, 2006).
- "And the bottom line is that standardized testing. Let's face it. And everybody knows that and if anything has to get a little bit of attention it's going to be science and social studies. I mean, I don't like that it's like that. But it's a reality so especially as the year goes on teachers start to get nervous about am I meeting all these standards. How am I addressing what we have to address? And then after that you start thinking about the extras." (Focus Group Interview, May 10, 2006).

Table 1. C14 School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	747	733	758	
Black, non-Hispanic	1	0	2	
Asian	3	2	1	
Hispanic	2	1	0	
Indian, Alaskan Native	0	0	0	
White, non-Hispanic	741	730	755	
School location (rural, suburban, urban, mid-size central city)	Urban Fringe of Mid-size City	Urban Fringe of Mid-size City	Urban Fringe of Mid-size City	
School type (public, private, charter, magnet)	Public	Public	Public	
Title 1 status (yes or no)	Yes	Yes	Yes	
Free and reduced price lunch	268	287	293	

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 24, 2007 from http://nces.ed.gov/ccd/bat/

Table 2. Summary of Academic Needs Identified by C14 in 2005

Priority	Discipline	Category	National Standard
1	National Educational Technology Standards		Design, develop, publish, and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom.
2	National Educational Technology Standards		Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum.
3	National Educational Technology Standards		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	National Educational Technology Standards		Research and evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources concerning real-world problems.
5	National Educational Technology Standards		Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
6	National Educational Technology Standards		Use content-specific tools, software, and simulations to support learning and research.
7	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study
8	Standards for Technological Literacy	Design	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
9	Principles and Standards for School Mathematics	Representation	Create and use representations to organize, record, and communicate mathematical ideas
10	Standards for Technological Literacy	Design	Students will develop an understanding of engineering design

Source: C14 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that C14 Teachers Completed

National Elementary School Principal Conference (Seattle, WA)
NES Orientation Workshop (Cleveland, OH)

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That C14 Teachers Incorporated into Their Instruction

NASA websites
NASA funding
AES services
Videoconferencing unit/DLN
NASA personnel

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. C14 ISTEP+ Grade 3 Scores

	English/Language Arts	Math
2004	79%	65%
2005	81%	80%
2006	69%	73%
2007	81%	78%
State Average in 2007	74%	72%

Source: ISTEP+ Results. (2006-2007). Indiana Department of Education. Downloaded 05-24-2007 from http://doe.state.in.us/

Table 6. C14 ISTEP+ Grade 4 Scores

	English/Language Arts	Math
2004		
2005	74%	78%
2006	79%	76%
2007	66%	73%
State Average in 2007	75%	75%

Source: ISTEP+ Results. (2006-2007). Indiana Department of Education. Downloaded 05-24-2007 from http://doe.state.in.us/

Table 7. C14 ISTEP+ Grade 5 Scores

	English/Language Arts	Math
2004		
2005	68%	80%
2006	76%	88%
2007	65%	85%
State Average in 2007	66%	76%

Source: ISTEP+ Results. (2006-2007). Indiana Department of Education. Downloaded 05-24-2007 from http://doe.state.in.us/

Table 8. C14 ISTEP+ Grade 6 Scores

	English/Language Arts	Math
2004	76%	83%
2005	75%	83%
2006	76%	87%
2007	84%	91%
State Average in 2007	71%	80%

Source: ISTEP+ Results. (2006-2007). Indiana Department of Education. Downloaded 05-24-2007 from http://doe.state.in.us/

NASA Explorer Schools Case Study Profile: D143
2005 Cohort—Urban, California, Public Middle School: Grades 7-8

Summary Comments Regarding D143
D143 is a California public middle school located in the urban fringe of a large city. It serves a population of 7th and 8th grade students numbering approximately 1,200 with a staff of about 100. D143 is a Title I school with a predominantly Hispanic student population (93%) and with 69% of its students qualifying for free or reduced lunch. Although D134 is a public school, students are required by the school district to abide by a formal uniform policy. More details are provided in Table 1.

Here are some of the successes that D143 achieved during its three-year period as a NASA Explorer School:

- D143 has created an atmosphere promoting NASA through bulletin boards in their cafeteria kept up-to-date with information about science, NASA, and science exploration.
- D143 has involved their field center staff in some of their science experiments.
- D143 has made their teachers aware of the NASA online resources and the Educational Resource Center (ERC).
- D143 has engaged the community (fire department, district personnel, Northrup Grumman, and member of Congress) through their NES activities. Their activities have been reported on the radio, television and in their local Spanish newspaper.
- D143 has used NASA curriculum to meet academic needs. The curriculum has been used schoolwide with students, primarily in science classes.
- D143 has shared NES resources and opportunities with D143 families, as well as with regional educators.

As a school that serves a predominantly poor population, D143 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- Late receipt of NES funds delayed the purchase of videoconferencing equipment and the use of the Digital Learning Network (DLN) which was one of the major goals of the D143 NES team.
- D143 would like to engage more teachers to participate fully in the NES program.
- A low level of parent education and lack of home computers is a limiting factor. D143 has addressed this by having a community liaison on campus who interacts with all of the parents. The community liaison speaks to parents during their monthly meetings about the NASA program and about current activities. She uses the "Connect Ed" telephone system to

contact the parents and give them messages. She has taken a group of parents to a [FIELD CENTER D] open house.

- Another obstacle is the California State Testing. Time is needed to prepare for the testing and during the actual testing period all of the time is dedicated to testing.
- It has been a challenge for D143 to integrate NASA resources into the curricula because each department has "pacing charts" which they are required to follow.

We examined schoolwide achievements at D143 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 transcript of A focus group interviews conducted by telephone with the D143 NES team on May 24, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES D143 team was formed in 2005 with five members. The team consists of the assistant principal/team administrator, team lead/8th grade physical science and algebra teacher; technology person/8th grade computer literacy teacher; 8th grade algebra and 8th grade physical science teacher; and a science teacher. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation D143 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 an NES kickoff, NES Student Symposium, Microgravity Experiments, NES workshops, and a Family Night. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that D143 has taken advantage of as a NASA Explorer School.

The next section examined the extent to which the D143 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

- "We've invited our, our NES team, our NES coordinator and aerospace educator to be involved with some of our science experiments. So they've been involved with that" (Focus Group Interview, May 24, 2006).
- "And I'm going to the NASA site quite a bit now just to find out more so that I can implement it into my program and whatever I'm teaching in

> technology to my classes and to my students, then I incorporate NASA things. So this has been a tremendous build for me so that I can grow more myself as well we make the students more aware of what's out there. So I've, I've truly enjoyed it because I've been to the Baltimore one, the ITEA conference. I'll be going for the summer workshop in Virginia for the technology immersion and as [another teacher] said, will be going to Alaska in July. So I'm looking forward to more opportunities and being able to implement more into my classes" (Focus Group Interview, May 24, 2006).

In addition to our analyses from case study, we report some key findings from the survey data on D143. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, one teacher said "sometimes", one said "1-3 times per month", one said "1-3 times per week", and one said "almost everyday."
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or task, two teachers said "1-3 times per week", and two said "sometimes" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often they accomplish the following goals:
    - Elicit students' ideas and opinions: Two teachers responded "always", one responded "very often", and one said "sometimes."
    - Get students to justify and explain their reasoning: Two teachers responded "always", one responded "very often", and one said "sometimes."
    - Have students relate what they are working on to their own experience: Two teachers responded "sometimes", one responded "very often", and one said "always."
- Four teachers completed the Teacher Needs and Involvement surveys. In responding to how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, three teachers said "quite a bit", one said "some."

Guideline 2. Time Intensive.

- "Also we would like to get as many of our staff members to participate in all these workshops that going out. Right now we are not as successful as we want to be. But in the future we would like to pull as many teachers to participate in all these fabulous things that NASA is offering in different areas of the United States" (Focus Group Interview, May 24, 2006).

- "We do emails, mass emailing to our teachers. Those who open their email they can see it. And then we have a white board that tells them what's going as they walk by it. And we also put things in their mailboxes just to tell them what's going on. And like George said, we also have the monthly meeting, we have at least once a month. We update them on what's going on with the NES programs" (Focus Group Interview, May 24, 2006).
- "We are sending one teacher to the NES Technology Immersion Workshop. [Teacher] plans to participate in many workshop sessions and bring back as many resources as possible for the rest of the staff at [D143."[1]
- Two D143 teachers traveled to Anchorage, Alaska, for the AIM Alaska Workshop. They earned GLOBE certification. They learned about noctilucent clouds (NLC) and how to photograph them.[1]
- A Lunar/Meteorite Sample Certification Teacher Workshop was offered for D143 teachers and teachers from surrounding schools. "We are inviting schools in our district and nearby NES schools."[1]
- The D143 NES team makes sure that new team members are engaged and informed by offering an introductory session "NES 101 [Field Center D]." "New members are provided an introductory to the NES program and enjoyed walk-through tour of the [FIELD CENTER D] facility."[1]
- "We are sending one administrator to the NES Administrator Workshop. [Principal] plans to participate in many workshop sessions and bring back as many resources as possible for the rest of the staff at ."[1]
- "A math/science teacher will attend the NSTA conference in St. Louis, Missouri. The teacher plans to participate in different conference sessions and bring back as many resources as possible for the rest of the math and science staff at [D143."[1]
- "We are sending two math/science teachers [teacher names] to the NSTA conference in Baltimore. These teachers plan to participate in different conference sessions and bring back as many resources as possible for the rest of the math and science staff at D143."[1]
- "The [D143] staff will learn how to successfully connect to the DLN for educational programming. We will become comfortable with initiating a DLN connection and scheduling events."[1]
- "We are sending one science teacher to the NSTA conference in Salt Lake City, UT. [Teacher] plans to participate in many conference sessions and bring back as many resources as possible for the rest of the science staff at [D143]."[1]

[1] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007, from http://aesp.nasa.okstate.edu/efolio

- "[Teacher] will attend many sessions [at the National Council of Teachers of Mathematics (NCTM) Conference] to learn new techniques for teaching mathematical concepts and bring what he learns and resources back to D143 math teachers."[1]

Guideline 3. Classroom Practices.

- In response to the question of how difficult or easy the NES team found supporting teachers in integration of NASA activities in the curricula and documenting these activities as they relate to the implementation plan, they said, "We found that it was easier, somewhat difficult, in between somewhat difficult and extremely difficult because it was very hard to…tell the teachers…that it's easy to do this but they didn't buy it because they've got this pacing chart that they in each of department like language arts, whatever department they're in to implement this, you know whatever, the skills that you are teaching so it was hard to get them to buy into this. So we said that's why it was extremely difficult or somewhat difficult" (Focus Group Interview, May 24, 2006).
- "…. We are very driven by California standards now. And one of the things I've talked to them about is that really I think NASA should look at our standards and look where there's a match-up with their activities. Alright. So the point I was trying to make mid-sentence was that there's a difficult issue, you know, do we go to NASA and say this is, this is the curriculum standard item we want to address on galaxies and you know there's some activities we can do on that or do they come to us and say they have some activities on galaxies, would we like to use it? So what you got into is really a chicken and egg situation. So we get our work with the education specialists at our regional NASA facility are fantabulous, but this, the complication of California standards is one area we could probably all work together on to give more for everyone. To do more for you program and also more for our students" (Focus Group Interview, May 24, 2006).
- D143 created an after-school robotics club where "students learn to build, operate, and program LEGO Challenger kits to accomplish a given task just like the Mars Rover" (e-Folio, 2007). The club met after school on Fridays for one hour. They held 20 sessions.

Guideline 4. Content Knowledge.

- Two D143 teachers traveled to Anchorage, Alaska, for the AIM Alaska Workshop. They earned GLOBE certification. They learned about noctilucent clouds (NLC) and how to photograph them.[1]
- A Lunar/Meteorite Sample Certification Teacher Workshop was offered for D143 teachers and teachers from surrounding schools. "We are inviting schools in our district and nearby NES schools."[1]

Guideline 5. Active Learning.

- "They [math teacher and science teacher] deal with the subject matter of math and [math teacher] does the algebra part and math part and then [science teacher] does the science part" (Focus Group Interview, May 24, 2006).
- "The other thing that we do now in the form of communication with the rest of the teachers is we have monthly department meetings for math and science so that's another way we disseminate information to the rest of the teachers and try to get them infected. For our kickoff and such, [Name] went around and identified key teachers in language arts and history and spoke to them about maybe producing something that has to do with exploration. And so the kids had an opportunity to do some writing, some reporting. And so we put some of their work in our famous big huge bulletin board in the cafeteria" (Focus Group Interview, May 24, 2006).

Guideline 6. Coherence.

- In D143's executive summary they stated, "Our teaching staff is implementing NASA activities that align with California Standards in mathematics and science. Activities in technology align with National Standards in Technology."[1]
- "[Teacher] went ahead spoke with the language arts teachers and that's another way we can try to integrate them into the program by letting the students do some writing. Because you know, writing, and math, and reading are so important – especially for the state test" (Focus Group Interview, May 24, 2006).
- "But last year when we sat together in [city], we actually had a benchmark made in our implementation plan and we look at them and we see which ones we are meeting and which ones we are not meeting. So, as long as we can, we try to look at all those thing we said we would do and some of them are accomplished and some of them are pending" (Focus Group Interview, May 24, 2006).
- D143 created an after-school robotics club where "students learn to build, operate, and program LEGO Challenger kits to accomplish a given task just like the Mars Rover" (e-Folio, 2007). The club met after school on Fridays for one hour. They held 20 sessions.
- D143 offered a class in robotics where "students learn to build, operate, and program LEGO Challenger kits to accomplish a given task just like the Mars Rover."[1] The class met daily throughout the school year for a total of 175 hours.

Summary of How School Meets Outcome 1.

The D143 NES team has been actively involved in the professional development workshops and attending conference. The knowledge they gain from NES is valuable. The team disseminates the NES information to other teachers through emails or white board communication. Teacher buy-in has been difficult as a result of state standard testing and busy scheduling in planning new materials that align with California Standards in mathematics and science. After-school robotic and class in robotic were established for the students to attend.

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

The D143 team purchased the following technologies with NES funding:

- Sony Videoconferencing Equipment
- Optoma Projection Unit
- Mindstorm Team Challenge Set with USB Cable
- Robotics Educator Site License 2.5
- 9v Motor
- Dell Laptop Computer
- DVD Recorder
- Portable Projection Screen
- Projector Bulb
- GPS Units
- Batteries
- Battery Charger
- USB Microscope

Teachers are aware of the online resources provided in NASA website. School provides telescopes for the students and family to look at the moon or the stars when there is a kickoff event.

- "I think the teachers know about our online, about all the online stuff that you have available at the NASA site. So they're all aware that so we wanted them to know about all this online stuff that they can get. And also the, the educational resource center. They all know about that so they can get the great stuff that's there" (Focus Group Interview, May 24, 2006).
- "As a matter of fact, I'm not sure we even mentioned it, we even got telescopes. We got four telescopes from Bushnell. That was a surprise to us. And we even used those telescopes during one of our nights that we had for the kickoff. And we had a line of people just, you know look at that, trying to look at the moon or the stars" (Focus Group Interview, May 24, 2006).
- "We are sending one teacher to the NES Technology Immersion Workshop. [Teacher] plans to participate in many workshop sessions and

bring back as many resources as possible for the rest of the staff at [D143."[1]

- Two D143 teachers traveled to Anchorage, Alaska, for the AIM Alaska Workshop. They earned GLOBE certification. They learned about noctilucent clouds (NLC) and how to photograph them[1]
- "The [D143] staff will learn how to successfully connect to the DLN for educational programming. We will become comfortable with initiating a DLN connection and scheduling events."[1]

The D143 staff will learn how to successfully connect to the DLN for educational programming. They will become comfortable with initiating a DLN connection and scheduling events.

The NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate more inclusive picture of how D143 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "11-20 times" a year. Teachers also responded only "6-15 times" for using NASA materials in their classroom in a year.

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

Searching for postings about D143 outreach and family events on the web, we found the following comments from parents of D143 students. The overall parent feeling is positive.[2]

> "The school has the best leader in the school district. She tries her best to run the school well and supports her staff. Making sure everyone is functional and responsible" (April 2007).
>
> "D143 has the best drill team and marching band ever. [Name] is an outstanding band director. The drill team girls also work extremely hard to win first place. They also have a wonderful sports program. And wonderful teachers like [Teacher names]" (February 2007).

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[2] The Great Schools website lists overall positive comments from parents of D143 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 4, 2007 from http://www.greatschools.net/).

"The staff and programs at D143 are simply outstanding. With an award winning band, drill team, and tall flags along with award winning programs for art and woodshop" (March 2006).

"I think D143 offers a wide variety of extra-curricular activities. They have a scholarship program that has provided my daughter with more than 7500 dollars. She has been able to enhance her view of the world to better her chances to get into a good college. The school also has an award winning music/band program, outstanding sports, and a sailing club. Great teachers and teacher's aides. I am overall highly satisfied about the education offered at the school. Thank You" (June, 2005).

- "We've contacted various businesses. When we had our NASA kickoff, we must have sent out, I don't know how many letters we sent out, but hundreds of letters… But we've had hundreds of letters sent out to our community letting them know that we are a NASA Explorer School and these are some of the things that, that will be happening at our school." (Focus Group Interview, May 24, 2006).
- "We also had a parent night in which two of the members, […] and [the team lead] had the opportunity to do some demonstrations and then the parents and their children had the opportunity to actually participate in the experiment and that was very, very successful. Our kickoff was exciting because we had various stations throughout the campus. We had district personnel come down. We had the fire department come down. just to see. Northrup Grumman has also been down here…They did a space station" (Focus Group Interview, May 24, 2006).
- "One of the ways we kind of tackled the issues of parents is we have a community liaison on our campus. She interacts with all the parents because we have 1,200 students at our campus so she interacts with a majority of them and she's instrumental in speaking to them during our monthly meetings about the NASA program or activities that are going on. She does a phone call, which is called a "Connect Ed." It's a, it's a system in which we are able to contact all of the parents and give them messages. Just recently, it's funny you said that, this past Saturday she took a group of parents to [FIELD CENTER D] to open house. That was a nice way to expose some of our parents and some of the children to, you know, this whole NASA, [FIELD CENTER D] relationship that we have" (Focus Group Interview, May 24, 2006).
- "I have those telescopes out … during our parent conference night and showed them Venus and Mars. So, you know, parents were out there and kids were out there looking through telescopes" (Focus Group Interview, May 24, 2006).

- A Lunar/Meteorite Sample Certification Teacher Workshop was offered for D143 teachers and teachers from surrounding schools. "We are inviting schools in our district and nearby NES schools."[1]
- During the Forces and Motion Family Science Night, D143 students "build and launch different types of rockets and explain the engineering and scientific processes behind rocket function to their families."[1]
- "We will host a career day for students and their families with the goal of exposing students to STEM-G career options. We will work with local business organizations to invite local business persons to set up a display in a booth-type setting."[1]
- During Earth-Moon Astronomy Night, "Families will participate in activities to learn the distance between earth and the moon and the topography of each. Lunar rock and soil/regolith samples will be available for viewing. Telescopes pointing to the moon, Saturn, and Venus will be available for use."[1]
- During Family Chemistry Night, "Families of 8th grade students will participate in hands-on inquiry based chemistry experiments that will require them to follow the scientific method. Students will predict, measure, and analyze results with the help of their families."[1]

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

NES e-Folio showcases the activities that students have participated in or will participate in through NES. For example, students learned to build, operate, and program robotics to accomplish a given task. The AES also came and demonstrated several activities where family members were involved.

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

- "I have those telescopes out during our parent conference night and showed them Venus and Mars. So…you know, parents... and kids were out there looking through telescopes" (Focus Group Interview, May 24, 2006).
- D143 created an after-school robotics club where "students learn to build, operate, and program LEGO Challenger kits to accomplish a given task just like the Mars Rover."[1]
- D143 offered a class in robotics where "students learn to build, operate, and program LEGO Challenger kits to accomplish a given task just like the Mars Rover."[1]

- D143 invited an AES to present an activity on Water Rockets to the students. In the activity "students will create a rocket that is made up from a 2-liter bottle. The rocket will contain a fresh egg. The parachute will help the descent of the rocket to safely land the egg."[1]
- Seventh grade sciences classes participated in a Lunar and Meteorite Sample Viewing activity. "Students will do the edible rocks activity in their classrooms to establish basic understanding of a rock structure. Students will then hypothesize about the structure and appearance of a moon rock. Teachers will then escort students to the cafeteria where moon rock and meteorite samples will be on display for actual artifact comparison to student hypothesis."[1]
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- During Family Chemistry Night, "Families of 8th grade students will participate in hands-on inquiry based chemistry experiments that will require them to follow the scientific method. Students will predict, measure, and analyze results with the help of their families."[1]
- Seventh grade students at D143 participated in "Seeds from Space." "Students will grow plants and compare results from the different types of seeds: earth exposed (1 atmosphere of pressure), space exposed (0 atmospheres of pressure), underwater exposed (2 atmospheres of pressure)."[1]
- At the Nutrition/Space Food Family Night, "Students learn about nutrition as part of their science curriculum and will apply what they have learned as they study with their families the importance of good nutrition. Families will study space food and discuss the variety of foods available for space travel."[1]
- As part of the Inquiry Based Microgravity Experiment Preparation, "students will produce an idea for an experiment to fly in microgravity. Each class will submit the top three ideas which will be presented to the general student body during an assembly. Students will vote on the entries and narrow the field to the top 5 experiments. Teachers and NASA staff will select the flight experiment."[1]
- "In honor of the International Polar Year, students will be exposed to the changing condition of the polar caps. They will participate in an activity which measures the volume of water in reference to sea level regarding floating ice vs. level ice. This activity involves science, mathematics, geography, and technology. Students will also use the Internet to research Antarctica."[1]

Noticeable curiosity in STEM-G topics and events

- "And our students were really, really in tune. They were doing every, everybody did their little part. And you could see them, for example, [teacher] out there. He's rocket launching what he was doing. They knew exactly what was the plan and what was they doing. We had, for example, inside the room we had the planetarium and the students were excited about building it themselves from scratch. And all those things that was going on, rockets he was shooting up in the air. So our students know exactly what is going on and then to see stickers of 'My child goes to NASA Explorer School' at the back of all, of all these vans now sticking them, that makes them feel proud that their school is a NASA Explorer School. We have a flag that flies, for example, and our marquee says the same thing. So they know that their school is different and then something special about" (Focus Group Interview, May 24, 2006).

Attitudes changes about learning

- "You know, another thing too that's great is we had the opportunity to have a astronaut come to our school. Dr. Roger Crouch has been on a couple of STS flights. That was arranged. That was wonderful. Our students were excited. He had a chance to eat lunch with them and interact with them" (Focus Group Interview, May 24, 2006).
- "Yeah. You know I think one of the things that…just at this general, actual level, a lot of the kids need something to look forward to, some kind of enthusiasm, some kind of a positive reinforcement. And I think the NASA program does provide it. Because I know that when I go around to the classrooms there are either stickers, they're up on the wall, or, or sometimes even indirectly in the conversation, some students will ask about NASA. So that kind of tells me that the teachers themselves in their classrooms have actually been informing the students. As a matter of fact, there's like a website that's on the page in which the students are able to participate in some kind of a answer the question and then the first group or first "x" amount of students that answer get a little prize. So I know some students have actually participated in, in that. And they've actually gotten something from NASA like a pin with an astronaut on it" (Focus Group Interview, May 24, 2006).
- "I think this has been a dream for us to join NASA Explorer Schools. The fact that we are flying NASA flag, and we have bumper stickers that says 'My child goes to a NASA Explorer School' it gives us a lot of pride because our students are from low-income families. We are inner city. They can not leave the community easily." (Focus Group Interview, May 24, 2006).

Actively participation in hands-on and authentic scientific research

- Seventh grade students at D143 participated in "Seeds from Space." "Students will grow plants and compare results from the different types of seeds: earth exposed (1 atmosphere of pressure), space exposed (0 atmospheres of pressure), underwater exposed (2 atmospheres of pressure) ."[1]
- As part of the Inquiry Based Microgravity Experiment Preparation, "students will produce an idea for an experiment to fly in microgravity. Each class will submit the top three ideas which will be presented to the general student body during an assembly. Students will vote on the entries and narrow the field to the top 5 experiments. Teachers and NASA staff will select the flight experiment."[1]
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Outcome 5. Increased student knowledge about careers in STEM-G.

NES teachers perceive that having the NASA scientists in the school help students understand what NASA is "really about. "

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

Increase understanding of the enthusiastic about STEM-G careers

- "And being successful means we are going to be the people who reach the next generation of astronauts. And have them here and I think we are trying to get as much as possible information out there to them. And I think that's what NASA expects of us. Spread the word as far as you can do it" (Focus Group Interview, May 24, 2006).
- "We will host a career day for students and their families with the goal of exposing students to STEM-G career options. We will work with local business organizations to invite local business persons to set up a display in a booth-type setting."[1]

Share information with their peers and parents

- "We also had a parent night in which two of the members, […] and [the team lead] had the opportunity to do some demonstrations and then the parents and their children had the opportunity to actually participate in the experiment and that was very, very successful" (Focus Group Interview, May 24, 2006).
- During the Forces and Motion Family Science Night, D143 students "build and launch different types of rockets and explain the engineering and scientific processes behind rocket function to their families."[1]

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

D143 teachers plan to incorporate more inquiry and problem-based activities in the classroom and expose students to variety of technology applications. Two students had the chance to attend student symposium in Washington, DC, to present their work.

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

- D143 invited an AES to present an activity on Water Rockets to the students. In the activity "students will create a rocket that is made up from a 2-liter bottle. The rocket will contain a fresh egg. The parachute will help the descent of the rocket to safely land the egg."[1]
- Seventh grade sciences classes participated in a Lunar and Meteorite Sample Viewing activity. "Students will do the edible rocks activity in their classrooms to establish basic understanding of a rock structure. Students will then hypothesize about the structure and appearance of a moon rock. Teachers will then escort students to the cafeteria where moon rock and meteorite samples will be on display for actual artifact comparison to student hypothesis."[1]
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- "In honor of the International Polar Year, students will be exposed to the changing condition of the polar caps. They will participate in an activity which measures the volume of water in reference to sea level regarding floating ice vs. level ice. This activity involves science, mathematics, geography, and technology. Students will also use the Internet to research Antarctica."[1]

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

- D143 created a robotics club where "students learn to build, operate, and program LEGO Challenger kits to accomplish a given task just like the Mars Rover."[1]

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

- "A couple of weeks ago, two of our students along with [their teacher] went to the student symposium in Washington, DC, to do a presentation; I believe it was on Earthquake preparedness. And it went really, really well. And as a matter of fact, they did the exact same presentation in front of all sixty-five teachers that we have on our campus" (Focus Group Interview, May 24, 2006).
- Although the school performance is still below the state average, over the year, D143 has showed improvement on student achievement scores in language arts (from 19% to 26% in 2005 to 2006) and math (from 10% to 16% in 2005 to 2006).
- D143 did not meet AYP in the year of 2005-2006.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population		1272	1289	
Black, non-Hispanic		5	3	
Asian		56	65	
Hispanic		1198	1205	
Indian, Alaskan Native		1	2	
White, non-Hispanic		12	14	
School location (rural, suburban, urban, mid-size central city)		Urban Fringe of Large City	Urban Fringe of Large City	
School type (public, private, charter, magnet)		Public	Public	
Title 1 status (yes or no)		Yes	Yes	
Free and reduced price lunch		970	888	

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 4, 2007 from http://nces.ed.gov/ccd/bat/

Table 2. Summary of Academic Needs Identified by D143 in 2005

Priority	Discipline	Category	National Standard
1	Principles and Standards for School Mathematics	Number and Operations	Understand meaning of operations and how they relate to one another.
2	Principles and Standards for School Mathematics	Measurement	Understand measurable attributes of objects and the units, systems, and processes of measurement
3	Principles and Standards for School Mathematics	Algebra	Use mathematical models to represent and understand quantitative relationships
4	Principles and Standards for School Mathematics	Data Analysis and Probability	Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
5	Principles and Standards for School Mathematics	Problem Solving	Apply and adapt a variety of appropriate strategies to solve problems
6	National Science Education Standards	Physical Science	Motions and Forces
7	National Science Education Standards	Life Science	Life cycles of organisms
8	National Science Education Standards	Earth and Space Science	Structure of the Earth system
9	National Educational Technology Standards		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.
10	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study

Source: D143 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that D143 Teachers Completed

NES Orientation Workshop
Workshop (Houston, TX)
National Science Teacher Association (NSTA) Conference, (Nashville, TN)
AIM Alaska Workshop (Anchorage, Alaska)
National Science Teacher Association (NSTA) Conference, (St. Louis, MO)
ITEA Conference (Baltimore, MD)
Technology Immersion Workshop (Virginia)
[FIELD CENTER D] Robotics Workshop
NES Robotics Workshop
National Science Teacher Association (NSTA) Conference, (Baltimore, MD)
National Science Teacher Association (NSTA) Conference, (Salt Lake City, UT)

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That D143 Teachers Incorporated into Their Instruction

Field Center Personnel (Coordinator, AES, other staff, DLN coordinator)
Robotics
GLOBE
Noctilucent Clouds
Exploring the Moon Educator Guide
Meteorite Mysteries Educator Guide
Lunar sample disks
Meteorite sample disks
Rockets Educator Guide
Edible Rocks Activity
Moon Lithograph
NSTA website
NSTA publication
Digital Learning Network (DLN)
Size and Scale Activities
Lunar and Meteorite Samples
NASA tomato seed kits
Space Food Display
Space Food and Nutrition Educator Guide
Microgravity websites
Sounding rocket opportunity
Microgravity Educator Guide
NTSA Symposium: The Fragile Ice
Lesson Plan: Sea Level Change-Floating Ice vs. Land Ice

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. D143 CST Grade 7 Scores

	English Language Arts	Math
2003	14%	16%
2004	18%	20%
2005	29%	28%
2006	27%	31%
State Average in 2006	43%	41%

Source: CST Results. (2005-2006). California Dept. of Education. Downloaded 05-01-2007 from http://www.cde.ca.gov/

Table 6. D143 CST Grade 8 Scores

	English Language Arts	General Mathematics	Algebra I	Science
2003	13%	15%	52%	
2004	17%	11%	61%	
2005	19%	10%	64%	
2006	26%	16%	57%	18%
State Average in 2006	41%	26%	40%	38%

Source: CST Results. (2005-2006). California Dept. of Education. Downloaded 05-01-2007 from http://www.cde.ca.gov/

NASA Explorer Schools Case Study Profile: E25
2005 Cohort—Small Town, Mississippi, Public Elementary School: Grades 4-5

Summary Comments Regarding E25
E25 is the fourth and fifth grade school in its District. The school is located in a small town in Mississippi. The total enrollment is 246 with a student population that is close to 95 percent African-American. E25 is one of seven schools in its school district. It is located in a beautiful historic town on the banks of the Tennessee-Tombigbee Waterway. The total enrollment is 246, representing 133 boys and 113 girls. E25 is a Title 1 school with ninety-seven percent of the student population qualifying to receive free or reduced lunch. See Table 1 for more information on the school demographics.

Here are some of the successes that E25 achieved during its three-year period as a NASA Explorer School:

- E25 successfully incorporated NASA curriculum and activities into their regular school calendar. See Table 7 for details.
- The E25 NES team was able to meet regularly (twice each month) to monitor progress and make plans.
- E25 students were successfully engaged in interactive scientific research through GLOBE, ISS EarthKam Mission, CloudSat Network, and Winter's Story.
- E25 teachers utilized inquiry-based learning lessons through NASA resources including Webcasts, coupled pendulum activity, beluga whale activity, Echo the Bat activity, and the Night Sky activity.
- In addition to professional development through regional and national conferences and workshops, E25 brought professional development to the school with workshops by Aerospace Education Specialists. They had four workshops in 2005 and expanded to twelve workshops in 2006.
- Family and community involvement increased at E25.
- E25 provided opportunities for students to interact with professionals in STEM-G-related career fields.

As a school that serves a predominantly poor population, E25 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- Late NES funding caused problems for E25. They were not able to purchase videoconferencing equipment and missed an opportunity to do a StormE simulation. In addition, they were not able to buy materials as

planned for their weekly clubs. These problems were resolved when the funding arrived.
- Participation in NES meetings took E25 team teachers out of their classrooms and away from teaching.
- The Hurricane Katrina disaster affected E25.

We examined schoolwide achievements at E25 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 transcript of a focus group interview conducted by telephone with the E25 NES team on April 19, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES E25 team was formed in 2005 with five members: school administrator, team lead, 4th grade language arts teacher, 5th grade math teacher, and family coordinator. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation E25 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 and have instituted several (NASA Bytes, Short Learning Courses, On-Site Professional Development, NES Team Meetings, and Inquiry-Based Learning) as regular items on their school calendar. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that E25 has taken advantage of as a NASA Explorer School. See Table 7 for a detailed list of E25 activities.

E25 NES team members have attended professional development and special opportunities made available to them through the NASA Explorer Schools program. They reached beyond their team to encourage non-team members to attend conferences and special opportunities as well as actively bringing professional development onsite. E25 has ingrained NASA into every aspect of school life by involving the entire school, family, and community in NES-related activities. The NES E25 team members communicate news of opportunities, collect and distribute materials and activities, and actively plan to integrate

NASA curriculum into their classes. This has created an environment of excitement and pride in everything related to NASA.

The next section examined the extent to which the E25 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

- "We were very excited about the inquiry-based learning methods. These methods helped with teaching math, with getting new ideas, and it helped to create interest in science and in STEM-G classes (Focus Group Interview, April 19, 2006).
- "Teachers utilized the Digital Learning Network to communicate with at least one NASA professional at Stennis Space Center and other NASA affiliates [for a GEMS Workshop].[2]
- "NES Team members developed and administered a Student Technology Survey in 2005 with information about different technologies gained from the Orientation Workshop. After compiling the results of the survey, the faculty was informed about the technologies the students had access to and how they used them. After attendance at the Content Workshop, the NES team will revise and administer the Student Technology Survey and share the results with the faculty for the current year.[2]

In addition to our analyses from case study, we report some key findings from the survey data on E25. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, three teachers responded "1-3 times per month," two responded "sometimes," and one responded "1-3 times per week" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or task, two teachers said "1-3 times per month," two said "sometimes," one said "1-3 times per week," and one said "never" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often I16 teachers accomplish the following goals:
    - Elicit students' ideas and opinions: Three teachers responded "very often," two responded "often," and one said "always."

  - Get students to justify and explain their reasoning: Three teachers said "very often," and three said "always."
  - Have students relate what they are working on to their own experience: Three teachers responded "always," two responded "often," and one said "often."
- Twelve teachers completed the Teacher Needs and Involvement surveys. In responding to how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, one teacher said "a lot," four said "quite a bit," five said "some," one said "a little," and one said "not at all."

Guideline 2. Time Intensive.

- "A few teachers have gone to meetings provided by NASA and shared that information. Everyone took part in professional development. If we get information, we e-mail it and present it at faculty meetings. We have two major focus groups, one in the fall and one in the spring. The entire faculty participates" (Focus Group Interview, April 19, 2006).
- "We also have weekly clubs that involve the entire faculty and we use NASA material" (Focus Group Interview, April 19, 2006).
- "[Name], our superintendent of the school board, pre-approved any activity for the next three years because we are an NES school. For example, we applied for a Remote Sensing workshop and we were automatically approved to miss the first week of school" (Focus Group Interview, April 19, 2006).
- "We were limited in professional development and now we have more of that" (Focus Group Interview, April 19, 2006).
- "Interactive, online, professional development opportunities. One of our faculty members completed 'Lessons from the Ocean' in August and another plans to take the same course in March. Two faculty members completed WDLC Weather Center course in November 2006].[2]
- E25 has already planned for NES team members or other E25 faculty members to attend the NES Sustainability Conference].[2]
- "Four E25 faculty members will attend National Conferences. Two teachers will attend the National Geography Education Conference, NGEC, in October 2006, held in Nevada. Two teachers will attend the National Math Conference, NCTM, in Atlanta in March 2007].[2]

- "Four staff professional development workshops will be conducted at E25 by [AES]. These will include training on the DLN, the Smart Board, GLOBE, and GPS].[2]

Guideline 3. Classroom Practices.

- "Learning how to do math in a different way was especially exciting to me. It was learning how to do math in a hands-on way. This really taught me a lot. Students really like this way better than the traditional way" (Focus Group Interview, April 19, 2006).

Guideline 4. Content Knowledge.

- "We have been provided with so many resources that they were so easy to pick from. We used a lot of the resources presented at the workshops. [Name] is our aerospace educator and provided a lot of materials" (Focus Group Interview, April 19, 2006).
- "We organized binders with cross-integrated materials for faculty use" (Focus Group Interview, April 19, 2006).
- "Professional development and professional opportunities were awesome. We gained knowledge and experience" (Focus Group Interview, April 19, 2006).
- "There was a strong interest in science and in getting resources. This has been wonderful" (Focus Group Interview, April 19, 2006).
- "Teachers utilized the Digital Learning Network to communicate with at least one NASA professional at [Field Center E] and other NASA affiliates for a GEMS Workshop].[2]
- "Interactive, online, professional development opportunities. One of our faculty members completed 'Lessons from the Ocean' in August and another plans to take the same course in March. Two faculty members completed WDLC Weather Center course in November 2006].[2]
- E25 teachers attended the following sessions at the NCTM conference: "Measurement, fractions, geometry, NASA navigation, new and upcoming tools and programs for math and science, as well as how to make math fun. All sessions were based on representations for math and how to make math meaningful].[2]
- "Four staff professional development workshops will be conducted at E25 by [AES]. These will include training on the DLN, the Smart Board, GLOBE, and GPS].[2]

- "Applied and accepted to attend Winter's Story at Yellowstone National Park. The purpose of the workshop is to understand the role of the cryosphere, water cycle, weather protocols, interrelationship of weather and climate factors, solar system connection with ice and weather, and create an implementation plan to incorporate Winter's Story content, investigations, activities, and use of tools].[2]

Guideline 5. Active Learning.

- "We also developed a student technology survey and we were all quite surprised by the results. Most of us had very different perceptions about student technology ability" (Focus Group Interview, April 19, 2006).
- "In observing how team members work with each other and with other teachers, I found that they shared information completely. They got together with similar grades and with similar subject matter teachers. They met and planned as a team with faculty" (Focus Group Interview, April 19, 2006).

Guideline 6. Coherence.

Evidence is not available for E25.

Summary of How E25 Meets Outcome 1:
NES E25 teachers are excited about inquiry-based learning and actively applying such teaching strategy to their classrooms using NASA funded technology tools. The NES teachers have also established rapport with non-NES teachers and provided supports for the NASA activities implementation. Weekly annual meetings help the NES team members to stay on track and get the jobs done effectively. Teachers are adopting innovative and creative ways to teach their students. This has excited students to learn.

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

The E25 team purchased the following technologies with NES funding:

- Tamberg 770 MXP
- StormE Weather Simulation
- Tanberg 770 IP Only Model
- Tamberg 770 Natural Presenter Package
- WireOne (1 year remote one care NBD, 24x7 TeleSupport)
- Digital Camera

- GPS Unit (purchased 3 in 2005; added 11 more in 2006)
- Presentation Camera
- USB Adapter
- Gateway Computer

E25 technology purchases and teacher professional development were aligned with planned use of the technology in the context of NASA curriculum. They leveraged NES funds to apply for additional grant opportunities to purchase additional technology (GLOBE equipment and library equipment).

- "This year, being an NES school has helped with applying for grant opportunities. We got GLOBE equipment and our food service obtained a big fruit and vegetables grant. We got used to looking outside our school for other opportunities. Our partner-in-education has been very supportive. There was funding that was directed to the coast because of Katrina. Our local library wrote a large grant that involved technology" (Focus Group Interview, April 19, 2006).
- "NES team members and other faculty members will seek out grant opportunities to increase the amount of technology for the school].[2]
- "Four staff professional development workshops will be conducted at E25 by [AES]. These will include training on the DLN, the Smart Board, GLOBE, and GPS].[2]

The NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate a more inclusive picture of how E25 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "20-40 times (weekly)" a year. Teachers also responded only "6-15 times" for using NASA materials in their classroom in a year.

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

Searching for postings about E25 outreach and family events on the web, we found the following comment from a parent of an E25 student. The overall

parent feeling positive and appreciate of the standards set for the E25 community.[1]

> "E25 is the Best! From the principal to the teachers, this school shines. This school has a very professional atmosphere where learning and achieving are at the top of their list. [Principal] has done a wonderful job with this school and only expects the best from his teachers and students. I have nothing but respect for the effort that has been shown and put forth from educators at this school" (2006).

E25 keeps families informed about what is happening at the school through a website, a regular newsletter and a special "NASA Explorer School News" publication. Families are invited to school for many activities where they are able to experience some of what their children are experiencing during school hours. Families are provided frequent opportunities to participate in NES-related activities with their children.

- "We were excited about the extra opportunities to involve parents in special events" (Focus Group Interview, April 19, 2006).
- "The family involvement component was a huge success. We had a Sky Party and the community came all out for this. Many people said they would have come if not for the bad weather. We had hands-on experiments, we met an astronaut, and we would have used a telescope to look at the night sky, but the weather was too bad" (Focus Group Interview, April 19, 2006).
- E25 sends "The E25 Newsletter" with the "NASA Explorer Schools News" home with every child once a.[2]
- E25 has created a school web page which provides links to NASA sites and updates of student and family opportunities.[2]
- "Vision/NASA Night is held annually at the beginning of the school year to familiarize parents, students and stakeholders of the various progrE25 available at E25 which includes the NASA Explorer School Program."[2] "E25 families are given the opportunity to participate in two family reading and two math/science nights."[2]

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

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[1] The Great Schools website lists overall positive comments from parents of E25 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 3, 2007 from http://www.greatschools.net/).

The E25 NES team has taken advantage of a variety of NES opportunities to involve their students in STEM-G activities. E25 students have gone to [Field Center E] to meet astronauts. They have participated in live research and used NASA technology to gather data through GLOBE, Winter's Story, CloudSat, and the ISS EarthKam. E25 has developed a Space Explorer Club program that is designed to provide additional exposure to STEM-G activities and materials.

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

- "E25 students were invited to Stennis Space Center to meet the crew of Discovery STS-121. They also had an opportunity to visit the space museum."[2]
- E25 has developed a Space Explorer Club where "The students will rotate through teacher directed clubs designed in the math, science, geography, and communications areas. The club will meet once weekly for 1 hour. The students will rotate to a different club every 9 week grading period. NASA materials will be used to design club activities."[2]
- E25 students worked on practice activities to prepare for their ISS EarthKam mission where they use reference materials to select areas of the world to photograph. Students then make their own photo requests using the ISS EarthKAM SMOC pages.[2]
- "Students will use the GLOBE protocols to collect and report data to GLOBE scientists via the Internet. Students that are initially trained in a small class setting will train students in their science classes to follow the GLOBE protocols to take measurements. Students in the small class setting will also conduct a student-led investigation using other GLOBE school as collaborators."[2]

Noticeable curiosity in STEM-G topics and events

- "I do the yearbook also and it was hard to pick pictures because there were so many showing the students so engaged in one activity or another" (Focus Group Interview, April 19, 2006).

- "The school library has a NASA media center. This center is designed to expose and reinforce the students' interest in STEM-G related fields. The center provides students and teachers access to books, videos, CD-ROMs, and websites. NASA wallsheets are displayed in the library and through out the school building."[2]

"Students will be introduced to some of the acronyms that NASA uses by completing an "Let the Acronyms Fly" Internet search using the NASA website to find the answers. Students then will create their own Acronym Manual for our school. Labels for common items around the school will be placed, such as: wastebaskets-FOD-Foreign Object Disposal; Water fountain-HS-Hydration Station; Restrooms-RR; etc."[2]

Attitudes changes about learning

- "We loved to watch and see the excitement in the kids. If we forgot about a scheduled activity, the kids reminded us to do it." (Focus Group Interview, April 19, 2006).
- "Learning how to do math in a different way was especially exciting to me. It was learning how to do math in a hands-on way. This really taught me a lot. Students really like this way better than the traditional way." (Focus Group Interview, April 19, 2006).
- "We asked the students and they went on and on about what they enjoyed. They finally said that they could not pick only one thing. The program had a great impact on student excitement in STEM-G." (Focus Group Interview, April 19, 2006).

Active participation in hands-on and authentic scientific research

- "Students complete the CloudSat protocol and take photos of the sky in the cardinal directions using a convex mirror and digital camera and report data to the CloudSat Education Network during a CloudSat satellite overpass."[2]

Outcome 5. Increased student knowledge about careers in STEM-G.

E25 students were exposed to a variety of STEM-G careers through their interaction with real scientists, especially through GLOBE and CloudSat. They met astronauts and visited [Field Center E]. E25 further supported the effort to increase student knowledge about careers in STEM-G by bringing professionals

in STEM-G careers to school once each month to talk to the student body about their career.

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

Increase understanding and enthusiasm about STEM-G careers

- "Students had many other opportunities that they would never have had, like meeting an astronaut (Focus Group Interview, April 19, 2006).
- "Professionals in various career fields related to STEM-G careers will be invited to address the student body once a month."[2]

Share information with their peers and parents

- E25 developed a program called NASA Bytes. "Students from the gifted program, Explore, will conduct research in the computer lab using the NASA website and find a topic that they find interesting to share with the entire student body. Before our clubs meet on Wednesdays, one of the students will read their piece of information over the school intercom. This activity is done each week at the same time throughout the year."[2]

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

E25 students were exposed to STEM-G concepts and skills through a variety of NASA curricula. They were provided with content, taught the necessary skills, and given many opportunities to apply them to real or simulated situations such as the StormE simulation, GLOBE, CloudSat, A Different Way of Seeing, Eyes in the Sky, EarthKam Mission and Winter's Story.

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

- "Students will use the GLOBE protocols to collect and report data to GLOBE scientists via the Internet. Students that are initially trained in a small class setting will train students in their science classes to follow the GLOBE protocols to take measurements. Students in the small class setting will also conduct a student-led investigation using other GLOBE school as collaborators."[2]

- One of the pieces of evidence posted by the E25 team is an inquiry-based learning activity that includes a satellite photograph of the United States at night provided to the students as part of a night sky activity. In this activity, students were asked to, "Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them."[2] The photograph provided represented a piece of evidence—however, we can only conjecture as to what the question was.

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

- E25 students and staff participated in two weeklong-themed NASA events, "A Different Way of Seeing" and "Eyes in the Sky." The events covered all STEM-G content areas and used the Echo the Bat book as supplemental reading material.[2]
- E25 students worked on practice activities to prepare for their ISS EarthKam mission where they used reference materials to select areas of the world to photograph. Students then made their own photo requests using the ISS EarthKAM SMOC pages.[2]

Two E25 teachers attended Winter's Story. They brought their experience to their classrooms by having students access the NASA planet lithographs, study the descriptions on the back [of the lithographs], and access the Internet to acquire additional information .[2]

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

E25 has met its annual progress goals for the 2004-2005 and 2005-2006 academic years. The NES team at E25 is motivated to work toward the next higher challenge as the team explains in their NES portfolio summary:

- "Disaggregated test scores indicate that E25 has shown improvement, however, our students must make tremendous strides if we are to reach our goal of becoming a level five school."[2]

Here are some of the strategies and team communications that E25 has used to integrate assessment and tracking of progress in their school improvement plan.

[2] Source: NASA Explorer Schools Digital Portfolios. Retrieved July 20, 2007 from http://aesp.nasa.okstate.edu/e-Folio

- "We will be bringing science on board for accountability next year. We did some preliminary testing and we were shocked at how far behind we were. Now, teachers will present an inquiry-based approach and they will be able to see how they can do hands-on activities" (Focus Group Interview, April 19, 2006).
- "We have not gathered data yet. Some questions were provided by the state and we were way off base" (Focus Group Interview, April 19, 2006).
- "We are using student surveys, parent surveys, student reflections, test scores at the end of the year, and teacher online surveys. After any event, they answer the surveys and reflections. We had a lot of fun reading the surveys from the students. There was an informal technology survey also" (Focus Group Interview, April 19, 2006).

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	271	274		
Black, non-Hispanic	249	262		
Asian	0	0		
Hispanic	2	1		
Indian, Alaskan Native	0	0		
White, non-Hispanic	20	11		
School location (rural, suburban, urban, mid-size central city)	Small Town	Small Town		
School type (public, private, charter, magnet)	Public	Public		
Title 1 status (yes or no)	Yes	Yes		
Free and reduced price lunch	259	267		

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 3, 2007 from http://nces.ed.gov/ccd/bat/

Table 2. Summary of Academic Needs Identified by E25 in 2003

Priority	Discipline	Category	National Standard
1	Principles and Standards for School Mathematics	Number and Operations	Compute fluently and make reasonable estimates.
2	Principles and Standards for School Mathematics	Number and Operations	Understand meaning of operations and how they relate to one another.
3	Principles and Standards for School Mathematics	Problem Solving	Apply and adapt a variety of appropriate strategies to solve problems
4	Principles and Standards for School Mathematics	Measurement	Understand measurable attributes of objects and the units, systems, and processes of measurement
5	Principles and Standards for School Mathematics	Data Analysis and Probability	Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
6	National Educational Technology Standards		Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
7	National Geography Standards	The world in spatial terms	How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
8	National Science Education Standards	Life Science	Diversity and adaptations of organisms
9	National Science Education Standards	Physical Science	Properties and changes of properties in matter
10	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study

Source: E25 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that E25 Teachers Completed

NES Orientation Workshop
NES Sustainability Conference
On-Site Professional Development Workshops
Winter's Story (Yellowstone)
National Council of Teachers for Mathematics (NCTM)
National Conferences

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That E25 Teachers Incorporated into Their Instruction

Digital Learning Network (DLN)
NASA Special Opportunities
Field Center personnel/AES
GLOBE website
NASA website
NASA wall sheet
NES e-Blast updates
NASA Webcasts
NASA CORE Bulletin Board Kits
NSTA e-Blast
NES website
NASA lessons/activities, books, CDs, DVDs
Computer lab
SmartBoard™
GPS unit
Lessons/activities provided by AES
NASA lithographs: The Planets
Winter Story website
National Space Science Data Center Planetary Fact Sheets
Student Observation Network
NASA scientists and students
S'Cool Cloud Identification Chart
Solar System Lithographs
Water Cycle Animation (GRC)
Teleconference with Don Pettit

ISS EarthKam website
Stennis Space Center
Activities developed by NES team at Remote Sensing workshop
CloudSat Education Network
Live, short courses
Compiled notebooks of grade appropriate NASA materials
NES PowerPoint
Photographs from NES activities
Fun Activities Packet with NASA and educational links
NASA Explorer News I
NASA videos
250 copies of the Student Technology Survey
GEMS DLN Workshop

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. E25 MCT Grade 4 Scores

	Reading	Language Arts	Math
2003	88%	70%	67%
2004	96%	78%	88%
2005	95%	84%	83%
2006	88%	73%	75%
State Average in 2006	88%	78%	82%

Source: MCT Results. (2005-2006). Mississippi Dept. of Education. Downloaded 05-02-2007 from http://www.mde.k12.ms.us/

Table 6. E25 MCT Grade 5 Scores

	Reading	Language Arts	Math
2003	89%	73%	58%
2004	86%	68%	65%
2005	88%	87%	72%
2006	88%	73%	62%
State Average in 2006	84%	73%	71%

Source: MCT Results. (2005-2006). Mississippi Dept. of Education. Downloaded 05-02-2007 from http://www.mde.k12.ms.us/

Table 7. E25 NES Activities[2]

Aug-05
Acromania
Jul-06
Grant Opportunities
Aug-06
E25 Web Page
Inquiry Based Learning
Live, Short Courses
NES Team Meetings
Space Explorer Clubs
Vision/NASA Night
Sep-06
E25 Newsletter/NASA Explorer Schools News
E25 Students Meet Crew of STS-121
Family Reading and Math/Science Nights
Grant Opportunities
Inquiry Based Learning
Monthly NASA bulletin board displays
NES Team Meetings
Special Opportunities
Oct-06
Acromania
GLOBE
Inquiry Based Learning
ISS EarthKam
Monthly NASA bulletin board displays
NASA Bytes
NASA Media Center
National Conferences
NES Team Meetings
Professional Development Workshops
Nov-06
"A Different Way of Seeing" NASA Week 1 "Eyes in the Sky" NASA Week 2
Family Reading and Math/Science Nights
GLOBE
Inquiry Based Learning
ISS EarthKam
Live, Short Courses
Monthly NASA bulletin board displays
NASA Bytes
NES Team Meetings
Student Technology Survey
Dec-06
Cloud Sat Network
GLOBE

Inquiry Based Learning
Monthly NASA bulletin board displays
NASA Bytes
NES Team Meetings
Stem-G Career Professionals
Jan-07
Digital Learning Network
GLOBE
Grant Opportunities
Inquiry Based Learning
Monthly NASA bulletin board displays
NASA Bytes
NES Team Meetings
Professional Development Workshops
Winter's Story - Peggy Bearden
Winter's Story- Marie Cayson
Feb-07
Family Reading and Math/Science Nights
GLOBE
Inquiry Based Learning
ISS EarthKam
Monthly NASA bulletin board displays
NASA Bytes
NES Team Meetings
Professional Development Workshops
Stem-G Career Professionals
Winter's Story - Peggy Bearden
Mar-07
"A Different Way of Seeing" NASA Week 1 "Eyes in the Sky" NASA Week 2
GLOBE
Inquiry Based Learning
Monthly NASA bulletin board displays
NASA Bytes
National Conferences
NCTM Conference
NES Team Meetings
Stem-G Career Professionals
Winter's Story - Peggy Bearden
Apr-07
Cloud Sat Network
Family Reading and Math/Science Nights
GLOBE
Inquiry Based Learning
Monthly NASA bulletin board displays
NASA Bytes
NES Team Meetings

Stem-G Career Professionals
Winter's Story - Peggy Bearden
May-07
Cloud Sat Network
GLOBE
Inquiry Based Learning
Monthly NASA bulletin board displays
NASA Bytes
NES Team Meetings
Professional Development Workshops
Stem-G Career Professionals
Jun-07
Sustainability Conference

NASA Explorer Schools Case Study Profile: F59
2005 Cohort—City, Texas, Public Elementary School: Grades PK-5

Summary Comments Regarding F59
F59 is large, central city, public elementary school located in Texas serving students in grades K-5. The total student population was 577 in the 2004-2005 academic years with a student population that was 66% Hispanic. In 2004-2005, the school qualified as a Title 1 school with 52% of students eligible for free or reduced lunch. The majority of the student population is considered at-risk as defined per state and federal criteria. See Table 1 for additional demographic details.

Here are some of the successes that F59 achieved during its three-year period as a NASA Explorer School:

- F59 held afterschool camps and successfully established robotics teams.
- F59 reported increasing numbers of students, families, team members, and non-NES teacher participation in DLN activities.
- F59 leveraged their NES funding and established a partnership with the Space Grant Consortia.

As a school that serves a high minority, low-income population, F59 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- F59 schools are required to follow very strict guidelines regarding curriculum and testing which made finding time for implementation of the NES program a challenge.
- F59 found that the late receipt of NES funds created a challenge.
- Changes in administration at F59 have created challenges. "There have been many challenges at the school. Next year, there is a possibility there will be more changes. We have sitting here an administrator that has been changed twice this year. One Vice-Principal left right after we got the award to be a NASA NES school, and then the Principal left a few weeks ago. Out of the six people sitting here, I am new and 2 or 3 of the others may be leaving next year" (Focus Group Interview, May 2, 2006).

We examined schoolwide achievements at F59 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 transcript of a focus group interview conducted by telephone with the F59 NES team on May 2, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES F59 team was formed in 2005. The team is made up of five members including the team lead who serves as the team technology coordinator, an informal educator who is a math specialist, a fifth grade teacher, a gifted and talented teacher, a school administrator, and a second grade teacher. The current team administrator is a replacement for the original team administrator. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation F59 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 robotics, distance learning, family night, math night, 2007 flight week reduced gravity opportunity, and the science fair. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that F59 has taken advantage of as a NASA Explorer School.

The next section examined the extent to which the F59 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

- "A lot of activities are great but some do not lend themselves to be used more than once. We were doing math nights and kick-off and so many people participated that we needed a lot of activities. We have a library night once a month all year round" (Focus Group Interview, May 2, 2006).

In addition to our analyses from case study, we report some key findings from the survey data on F59. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, two teachers responded "1-3 times per week," and two responded "sometimes" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or task, two teachers responded "1-3 times per week" and two said "1-3 times per month" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often I16 teachers accomplish the following goals:

  - Elicit students' ideas and opinions: One teacher said "always," and two responded "very often."
  - Get students to justify and explain their reasoning: One teacher said "very often," and two responded "always."
  - Have students relate what they are working on to their own experience: One teacher responded, "sometimes, one responded "often" and another responded "very often."
- Only one teacher completed the Teacher Need and Involvement survey. In responding to how much anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, the response was "a little."

Guideline 2. Time Intensive.

- "The assistance was wonderful; invaluable. What they [NASA field center staff] brought to us we could not get anywhere else" (Focus Group Interview, May 2, 2006).
- "Overall, the teachers are more comfortable with the curriculum. They are upset about some of the changes. They said they can get the students more interested. Other teachers have been able to participate with professional development activities. Now, they are more comfortable teaching that subject area" (Focus Group Interview, May 2, 2006).
- One F59 teacher attended nine sessions at the NCTM 2007 Annual Meeting and Exposition. "This conference offered a selection of close to 1000 different workshops for attendants to view and participate in. It also included a large showcase of current materials and vendor booths to demonstrate current and upcoming technological and mathematical materials available for use in classroom."1
- F59's e-Folio indicates that the 2007 flight week reduced gravity opportunity involved 520 students, 44 families, three NES team members, two administrators, and 23 non-team teachers. In addition, F59 indicated that this activity involved the Space Grant Consortia as a partner."[1]
- A second grade teacher from F59 attended the Winter's Story Workshop. "A second grade teacher from our campus will be going to Yellowstone National Park to study weather, the water cycle, snow crystals, as well as extremeophiles with other teachers from all over the world to gain knowledge that they can apply and integrate into current curriculums to help enrich the learning of their students, and encourage them in the various fields of science, technology, engineering, math, and geography."[1] "[Two F59 teachers] attended the NSTA Conference in Salt Lake City.

[1] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007, from http://aesp.nasa.okstate.edu/efolio

Sessions attended included science, engineering, math, and technology activities."[1]

- In 2006, F59 reported in their e-Folio that "Four teachers from [F59] attended professional conferences this year thanks to NSTA. The teachers learned new lessons and activities and networked with other teachers around the country to enhance the STEM-G teaching. They then shared what they learned with the rest of the [F59] Faculty."[1]
- Forty-four F59 teachers participated in a Bubble Festival. "Bubble festival is provided to get individual to participate in hands-on activities. They explore bubbles in several different settings and are able to learn science and math in a very fun and productive way. The teachers at [F59] all gathered together to participate in a Bubble Festival. We had several different stations set up in the library so that each team could explore the wonderful world of Bubbles together and modify it to their own specific grade level. The teachers had a blast seeing who could blow the biggest bubble, make the most bubbles and were amazed to see themselves surrounded by a thin film of soap and water."[1]

Guideline 3. Classroom Practices.

The excerpt below describes how the F59 team is using the technologies and material resources provided to them as a NASA Explorer School. The quote below shows the progression that is occurring among the team members reflecting their integrating resources step-by-step and moving toward more scientific, inquiry-enabling technology tools. The NES digital portfolio as well as Tables 3 and 4 contained in the back of this case study report show that the technology tools match the professional development activities in which this school is engaged. Improving technological literacy is the second academic need sites by this school (See Table 2).

- "F92 was accepted into the NASA Explorer School Program in 2005 and this is our second year with the program. What have purchased many exciting things for our campus to help improve the learning for our students such as our DLN network, and robotics. We are hoping this year to include probes as well as PDA's to our list of technological resources. Using this NASA program, we have motivated students to learn, and have increased out TAKS scores in 5th grade."[1]

Another component of the classroom practice goals involves teacher discussions about teaching strategies and tracking their impact on student performance. The comment below shows that this team is in the habit of reviewing and improving their instructional activities—both in and out-of-school.

- "We have accomplished our assessments. We held camps after school, we have robotics teams. Time has been a factor and it is sometimes difficult to

have enough time to do the things you want to do. To address this, we made sure we got on the calendar early. For next year, we will make it part of the 5th Grade curriculum" (Focus Group Interview, May 2, 2006).

Guideline 4. Content Knowledge.

- "Some things were already in place at the school. NASA allowed us to expand with a space science theme" (Focus Group Interview, May 2, 2006).
- "I just got back form St. Louis and the North Council of Teachers of Math. I would never have had this chance if it were not for the program. I had the chance to focus on technology and it was science/tech/robotics. It let me broaden what I did and also let me be more focused" (Focus Group Interview, May 2, 2006).
- "Teachers and students at [F59] will participate in a variety of lessons and workshops through the DLN Network at NASA. This will enhance the curriculum and excite the children and staff about science and math concepts, and touch on all STEM-G areas."[1] F59 team indicated in the e-Folio that this DLN event will anticipate about 420 K-4 student, 100 5-8 student, and 44 family participants.

Guideline 5. Active Learning.

In the focus group interview one of the teachers explains how their state standards of learning and testing are organized and implemented.

- "Texas requires schools to follow very strict guidelines about curriculum and testing. The children must pass testing and benchmarks. It is very frustrating to have so many good initiatives and yet be bound by such strict guidelines. The guidelines are very specific about what to teach on what day. The Texas guidelines say to spend 2 days on this unit and 3 days on that unit. And the 5th grade year is spent in a review of all components" (Focus Group Interview, May 2, 2006).

The excerpt below explains how the F59 team organized their student involvement in the reduced gravity flight opportunity. This excerpt shows how the teachers connected this activity to their standards and also shows their understanding of the inquiry process.

- "All students in the 3rd, 4th, and 5th grade Gifted and Talented classes learned about microgravity and then worked in groups to write investigations for the reduced gravity opportunity. Once written, they followed their procedures and recorded their data, results and conclusions. Four of the investigations were submitted for the Reduced Gravity Opportunity, and one was chosen. The experiment will be performed by all students in grades K-5."[1]

Guideline 6. Coherence.
The F59 team has a plan for schoolwide implementation and campus-wide benefits from the NES program. Their plan for reform incorporates the new technologies they received as a NASA Explorer School:

- "Our plan is to reinforce, and enrich our science, mathematics, and technology programs at our school, by communicating with NASA through our DLN network. This equipment allows our staff and students to interact with NASA experts and have a visual experience on Field Trips, world exploration, experimentation and inquiry learning. These experiences can be taken back to the classroom so we can provide our students with continued exposure, real world activities, and direct application.
- "[F59] strategic plan facilitates instruction and the distribution of NASA materials throughout the campus. We believe that these materials should improve the entire campus, and not just a few grade levels. Therefore, we work with NASA to help integrate these materials and information into existing science and mathematical content providing our students with more opportunities for inquiry based learning."[1]
- "For the Science Fair and Curriculum Initiative, we wanted to stay focused and it went really well. The challenge was in the younger grades. NASA was a big help and the 5th grade, especially, used a lot of NASA resources" (Focus Group Interview, May 2, 2006).
- "Our team is part of our science committee. We took strengths from each committee member and built on that. Each member took an interest and focused on one of the four initiatives" (Focus Group Interview, May 2, 2006).
- "We found this easy to implement in the lower grades because they already have space in the curriculum timeline. The upper grades are more difficult because space is not strictly in the curriculum. For example, adaptations must be in there, but they study specific adaptations and you can not really take a broad aspect to this" (Focus Group Interview, May 2, 2006).
- "They [AES] helped us to modify things in terms of specialized grades" (Focus Group Interview, May 2, 2006).
- "When we ask people to come to the school, they agree to come and we are really trying to get more people in. So far, the partnerships have worked pretty well" (Focus Group Interview, May 2, 2006).

Summary of How F59 Meets Outcome 1.
F59 has shown that they are using NASA resources in their schoolwide implementation. The evidence is also documented in their e-Folio. The assistance from their NASA field center has been outstanding and the team could not have accomplished so much if they did not have those external resources. Attending professional development workshops and conferences has improved teachers' content knowledge in STEM-G related topics as well as their teaching methodologies. More students participate in the after-school programs that robustly use NASA materials. As the result of being a NASA Explorer School, F59 also has established partnerships with other schools and local businesses.

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

The F59 team purchased the following technologies with NES funding:

- Set of 30 student size safety glasses
- 10 adult size safety glasses
- 2 classroom sets (6/set) of lens packs
- LEGO Robotic Tech Kit
- ROBOLAB Software w/ site license
- Epson digital projector (2)
- Sony PCS-1 videoconferencing equipment
- Toshiba TDP-T98U digital projector
- PASCO 2-axis accelerometer (8)
- PASCO temperature sensor (8)
- PASCO motion sensor (8)
- Imagiworks ImagiProbe wireless sensing system (4)
- Deluxe introductory slide set
- Economy magnetic field lines demonstrator

As documented in the e-Folio, F59 has started using some of the purchased technological tools in their curriculum.

- "[F59] was accepted into the NASA Explorer School Program in 2005 and this is our second year with the program. We have purchased many exciting things for our campus to help improve the learning for our students such as our DLN network, and robotics. We are hoping this year to include probes as well as PDA's to our list of technological resources."[1] "Our plan is to reinforce, and enrich our science, mathematics, and technology programs at our school, by communicating with NASA through our DLN network. This equipment allows our staff and students to interact with NASA experts and have a visual experience on field trips,

> world exploration, experimentation and inquiry learning. These experiences can be taken back to the classroom so we can provide our students with continued exposure, real world activities, and direct application."[1]

The NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate a more inclusive picture of how F59 teachers integrate technology. The teachers' responses to how many days a year does a typical student in their classroom use a computer while teaching their class, the responses were "11-20 times "a year. We found that only one teacher completed the Teacher Needs and Involvement surveys. When he or she was asked how many days a year does a typical student in the class use a computer while teaching the class, the response was "11-20 times" a year. The response to how many times they used NASA materials in the classroom, the response was only "1-5 times."

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

Searching for postings about F59 outreach and family events on the web, we found the following comments from parents of F59 students. The overall parent feeling is positive and recognizes the positive and enthusiastic faculty.[2]

- "My son went to this school for 3 years and he got along very well there. I always enjoyed the atmosphere, it was tight knit and everyone seemed to know each other. The parents have a lot of involvement" (March 2006).
- "I have been disappointed in this school. Despite my request the teacher is slow to send information home and I am not kept current on events or things going on in the classroom. My personal opinion is the Kindergarten and First Grade need to have Paraprofessionals and Teachers Assistants in each classroom. This frees up the teachers from doing administrative work and enables more individual time with the children. Kindergarten and First Grade are the foundations for which education is built on. I don't understand why the schools in this district are not funded well enough to provide the services needed" (December 2005).
- "Fantastic Administration and Hardworking Teachers. We have 3 children who attend F59 and they are doing wonderfully and love going to school!

[2] The Great Schools website lists overall positive comments from parents of F59 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 23, 2007 from http://www.greatschools.net/).

> I don't think we could get a much better quality education for our children with a private school. I highly recommend this school" (March 2005)!

F59 has successfully increased the family and community participation in school events. The school also has family library night for STEM-G related topics once a month.

- "Our plan also includes expanding participation with families and our community. We accomplish this through varied activities, one of which is our NASA Family Night. During this activity, families come out to participate in activities, small experiments, and gain knowledge about NASA, and the space program. We also encourage family and community participation by having our annual Space Week. Finally, we have our annual Science Fair which includes experiments that are space related and encompass various areas of the STEM-G."[1]
- "We had family library night once a month. And also had a math night. We invited parents and students to come in and the parents helped out a lot with the activities. The major challenge was getting the parents to come after a while because they always come to so many other things" (Focus Group Interview, May 2, 2006).
- "We had a big family night in the fall and NASA was very helpful with it" (Focus Group Interview, May 2, 2006).
- "F59 held a NASA Family/Academic Night. Thirty-two families will be participating the event."[1]

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

The students are invited to participate in the student symposium through videoconferencing. Through the videoconferencing, students present and share their experiments to NASA scientists and other students. The student interest survey showed that students are interested in math, and enjoy using math to explore solutions to problems. Students are excited about future opportunities that NASA has for them.

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

- "The Student Symposium was held via video conferencing. [F59] Elementary School and a panel at [Field Center F] participated. The students connected with [Field Center F] and [F29]. We each presented

our RGO experiments. They were very interested in the other school's experiment. They asked them several questions. The students did an excellent job of presenting the experiment on magnetic fields in microgravity. They answered all questions presented by the panel at [Field Center F] and [F29] students."[1]

- "All 3rd, 4th, and 5th grade Gifted and Talented students participated in the simulated mission, Mission to Mars, at the Challenger Learning Center in San Antonio. Students worked in teams to perform mission tasks at Mission Control and on the space ship, ALPHA 543. Once back in the classroom, they also wrote about their experiences focusing on the impact it has had on them."[1]



- "Fall Robotics is a 5th grade activity. Students are given a set of instructions and must create a landscape and program to drive through the landscape. Spring robotics is an introductory 4th grade robotics course. Students learn basic programming. Competition in the spring is done with the top 2 fifth grade robotics partners."[1]

Noticeable curiosity in STEM-G topics and events

- "Fourth grade enrichment students will write and edit two school newspapers for all students at [F59]. One will be for the 3rd though 5th grades, and the other will be for the kindergarten through 2nd grades. There will be two editions during the year. The articles will focus on STEM-G concepts and NASA news. The information for the articles will be obtained from the NASA website." Samples are provided below."[1]

- Grades K-2

The Stargazer

Oak Hills Terrace—NASA Explorer School
November 2006—First Edition Grades K, 1 and 2

The Space Elevator
By Esperanza De Soto

NASA is trying to find an easy way to get spaceships in space. They call it the Space Elevator. A satellite orbits around the Earth and stays over the same city. The Space Elevator carries the ship on a magnetic field . All the ships are built together like a train. It takes the ships 36,000 kilometers above the Earth!

Rings Around Saturn
By Aungelize Canty-Cruz

In 2004, the Casini Spacecraft started taking pictures of Saturn. It is a probe. The probe found five more moons and one new ring on Saturn. It made flybys around Saturn's biggest moon, Titan. Later, another small probe went to look at Titan. Titan is the only moon that has an atmosphere. The scientists think it's exciting. Maybe we will fly to Saturn some day.

OHT NASA Night
By Nacer Ibaroudene and Emily Garcia

Come to our 2nd annual NASA Night. If you love to learn about science or math then this is the place for you! There will be lots of cool stuff to do: look through telescopes at stars, see our robotics lab, and do science activities. The book fair will also be in the library with lots of cool science books. Don't forget... all students and their families are invited. This awesome NASA night is on November 14, 2006 from 6:00 to 8:00pm.

Microgravity Fun
By Pierre Gutierrez

Armando Garza, Bryanna Vera and Alyssa Hall, three of Mrs. Puente's 5th grade GT students, wrote an experiment. It got chosen to fly on the C-9. They want to find out what happens to magnetic fields in microgravity. Every class will do the experiment in their class then Mrs. Puente and Ms. Bunch will do the experiment on the C-9. Mr. Garcia will be on the ground crew during the flight.

Eileen Collins
By Rene Carasco

Eileen Collins is an astronout. She was born in 1956. She became a pilot in 1990. She wanted to become an astronaut, so she did! She took tests, and worked hard to become one. She was the first woman to command a space shuttle mission. This is why **Eileen** is super cool!

Ag Ants
By Victoria Vargas

An Ag Ant is a small robot. Tony Grift helped NASA build the ag ant. They use it on farms to help farmers. It is 30 centimeters long. It checks soil and plants for sicknesses. NASA hopes to use an Ag Ant on Mars.

How To Make A Shuttle Dog
By Lidia Gonzalez

Do you want to make a shuttle out of food? You need to have one hot dog, one plate, one slice of bread, one small slice of cheese, a plastic knife, two string cheeses, ketchup and mustard. First, you need to wash your hands. Then cut your bread in the shape of a shuttle. Next put the cheese on the shuttle and put the hotdog on top. Turn it over and put the cheese sticks on each side. Squirt ketchup and mustard on it and your shuttle is ready to eat!

Credits

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Sponsor : Mrs. Puente
Proofreader: Kara Carnahan

Staff Writers: Esperanza De Soto, Lidia Gonzalez, Rene Carasco, Pierre Gutierrez, Victoria Vargas, Aungelize Canty-Cruz, Emily Garcia

Resources: www.nasa.gov

- Grades 3-5

The Stargazer

Oak Hills Terrace—NASA Explorer School
November 2006—First Edition Grades 3, 4, and 5

Orin
By Sierra Quevedo

Orion is a space ship that will fly to the moon in the future. The companies that are building Orion are North Grumman Boeing and Lockheed Martin. They started to build Orion on August 31st,2006. Orion's first flight to the moon will take place in 2020. In the future people can live on the moon. We can also study the moon. The astronauts are only going to build a space station on the moon. Maybe you will help build the space station.

Heidi
By Carissa Gonzalez

Heidi Marie Stefanyshyn-Piper remembers when she was 4 years old . She flew in a airplane. She always wanted to be a pilot, but she couldn't pass the eye test. Now she gets to fly in space because she is an astronaut. She was on the space shuttle mission called STS-115 . She worked hard to become an astronaut. She stayed an extra year in college because she likes learning so much. She also joined the Navy because she knew it would help her reach her goal of becoming an astronaut. As an astronaut, she is a small part of a very large team to put people in space. On the STS-115 mission she did two space walks. She helped put new solar panels on the ISS to provide more electrical power. On the second walk she helped set up another panel that will cool the station by sending heat out into space. This mission was important because it will help get the ISS finished by 2010. She said she was excited to be a part in this effort. Just think, it all started with a plane ride.

NASA Night
By Nacer Ibaroudene

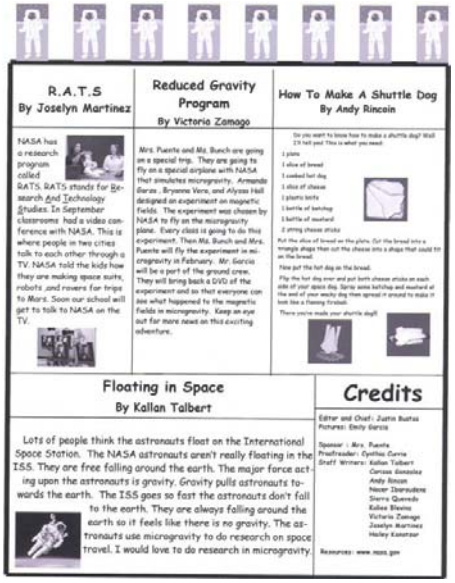
Come to our 2nd annual NASA Night. If you love to learn about science or math then this is the place for you! There will be lots of cool stuff to do like look through telescopes at stars, see our robotics lab, and you can also do science investigations. The book fair will also be in the library with lots of cool science books. Don't forget all students and their families are invited. This awesome NASA night is on November 14, 2006 from 6:00pm to 8:00pm.

Rings Around Saturn
By Hailey Kanatzar

The Voyager2 and Cassini spacecraft were both NASA probes that have both been close to Saturn. In 1981, Voyager 2 made one flyby of Saturn. In 2004 the Cassini spacecraft became the first probe to ever to enter the planets orbit. The Cassini spacecraft has been studying Saturn, Saturn's rings, and all of Saturn's 36 moons. Saturn's rings are made out of billions of pieces of ice. The information that Cassini and Huygens send back to Earth will give us ideas on how Saturn and its 36 moons came to be.

Recycling
By Kailee Taylor

During Apollo Mission astronauts first learned how to recycle. Astronauts have to recycle waste. If they don't it will make the spaceship heavier and take up valuable room. This could be a big problem on long trips to Mars. NASA is trying to find a way to burn the waste to make new products. This doesn't burn as well in microgravity, so scientists had to invent a new machine called the Vortex. The Vortex can burn the waste. When it burns the waste, it can create fertilizer for plants and even water. Then the plants can produce more oxygen for the astronauts to breathe. The best part is the astronauts will not have to take out the trash.



R.A.T.S
By Joselyn Martinez

NASA has a research program called RATS. RATS stands for Research And Technology Studies. In September classrooms had a video conference with NASA. This is where people in two cities talk to each other through a TV. NASA told the kids how they are making space suits, robots ,and rovers for trips to Mars. Soon our school will get to talk to NASA on the TV.

Reduced Gravity Program
By Victoria Zamago

Mrs. Puente and Ms. Bunch are going on a special trip. They are going to fly on a special airplane with NASA that simulates microgravity. Armando Garza , Bryanna Vera, and Alyssa Hall designed an experiment on magnetic fields. The experiment was chosen by NASA to fly on the microgravity plane. Every class is going to do this experiment. Then Ms. Bunch and Mrs. Puente will fly the experiment in microgravity in February. Mr. Garcia will be a part of the ground crew. They will bring back a DVD of the experiment and so that everyone can see what happened to the magnetic fields in microgravity. Keep an eye out for more news on this exciting adventure.

How To Make A Shuttle Dog
By Andy Rincon

Do you want to know how to make a shuttle dog? Well I'll tell you! This is what you need:

- 1 plate
- 1 slice of bread
- 1 cooked hot dog
- 1 slice of cheese
- 1 plastic knife
- 1 bottle of ketchup
- 1 bottle of mustard
- 2 string cheese sticks

Put the slice of bread on the plate. Cut the bread into a triangle shape then cut the cheese into a shape that could fit on the bread.

Take put the hot dog on the bread.

Flip the hot dog over and put both cheese sticks on each side of your space dog. Spray some ketchup and mustard at the end of your wacky dog then spread it around to make it look like a flaming fireball.

There you've made your shuttle dog!!

Floating in Space
By Kallan Talbert

Lots of people think the astronauts float on the International Space Station. The NASA astronauts aren't really floating in the ISS. They are free falling around the earth. The major force acting upon the astronauts is gravity. Gravity pulls astronauts towards the earth. The ISS goes so fast the astronauts don't fall to the earth. They are always falling around the earth so it feels like there is no gravity. The astronauts use microgravity to do research on space travel. I would love to do research in microgravity.

Credits

Editor and Chief: Justin Bustos
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Resources: www.nasa.gov

Attitude changes about learning

- F59 was recognized as an "All-Star School" based on spring 2006 Student Interest posttest items (Hull, 2007). They had a mean score of at least one standard deviation above the overall item mean scores on the following items:
  - How well do you think you will do in math this year? (4.33, 4-6 grades)
  - Rate how good you are at…Using math to explore solutions to problems (4.18, 4-6 grades)

- "Space inquiry interest has increased. Students are pumped about space. After school activities about space has increased. Students say that they go to NASA school. They think they are employees of NASA" (Focus Group Interview, May 2, 2006).
- "Teachers and students at [F59] will participate in a variety of lessons and workshops through the DLN Network at NASA. This will enhance the curriculum and excite the children and staff about science and math concepts, and touch on all STEM-G areas."[1]

Active participation in hands-on and authentic scientific research

- F59 students participated in the Flight Week Reduced Gravity 2007 Opportunity. "All students in the 3rd, 4th, and 5th grade Gifted and Talented classes learned about microgravity and then worked in groups to write investigations for the reduced gravity opportunity. Once written, they followed their procedures and recorded their data, results and conclusions. Four of the investigations were submitted for the Reduced Gravity Opportunity, and one was chosen. The experiment will be performed by all students in grades K-5."[1]

Outcome 5. Increased student knowledge about careers in STEM-G.

Through participation in NASA activities, students have become interested in joining NASA's future workforce. Students opportunities to present their knowledge about careers in STEM-G by editing the local newspaper and schoolvideos.

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

- "Space inquiry interest has increased. Students are pumped about space. After school activities about space has increased. Students say that they go to NASA school. They think they are employees of NASA" (Focus Group Interview, May 2, 2006).

Increase understanding and enthusiasm about STEM-G careers

- "For the newspaper and video component, the 4th grade students found articles on NASA sites and reworked articles into a newspaper. For the video series, we worked on a "Jobs in Space" activity and used NASA profiles. The students did an introduction to the profile, and ended the

segment that followed with a conclusion about the career. Time was a challenge" (Focus Group Interview, May 2, 2006).

- "Fourth and Fifth grade Gifted and Talented students are making videos on Jobs in Space. They utilize footage from the NASA Profiles video and add an introduction and conclusion utilizing students in the fourth and fifth grades. These videos are shown every Wednesday on the morning announcement show."[1]

Share information with their peers and parents

- "The Student Symposium was held via video conferencing. [F59] Elementary School and a panel at Johnson Space Center participated. The students connected with JSC and West Ward Elementary. We each presented our RGO experiments. They were very interested in the other school's experiment. They asked them several questions. The students did an excellent job of presenting the experiment on magnetic fields in microgravity. They answered all questions presented by the panel at JSC and West Ward students."[1I]
- In addition to holding a school science fair, F59 selected one experiment for presentation at the fair. "Students and teachers at [F59] will do research on various experiments and activities and will choose one to perform for the school on our science fair night. Students will then spend class time as well as time at home with their family, performing the experiment, logging their data, and creating a presentation to show their results and present on the night of the Science Fair."[1]

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

Students of F59 were given the opportunities to apply their skills in STEM-G topics, including science fair and robotics competitions.

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

- "For the Science Fair and Curriculum Initiative, we wanted to stay focused and it went really well. The challenge was in the younger grades. NASA was a big help and the 5th grade, especially, used a lot of NASA resources" (Focus Group Interview, May 2, 2006).

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

- "This year, the OHT staff will get together to provide our students with various activities relating to STEM-G. The students will perform these activities, as well as gain knowledge from exhibits brought in from NASA and by listening to NASA personnel. Students will also have the opportunity to use telescopes to locate planets and stars, as well as get a close look at the moon! Students will then apply the knowledge learned at this Academic night, to help them further their knowledge in the STEM-G areas."[1]
- In addition to holding a school science fair, F59 selected one experiment for presentation at the fair. "Students and teachers at [F59] will do research on various experiments and activities and will choose one to perform for the school on our science fair night. Students will then spend class time as well as time at home with their family, performing the experiment, logging their data, and creating a presentation to show their results and present on the night of the Science Fair."[1]
- "Fall Robotics is a 5th grade activity. Students are given a set of instructions and must create a landscape and program to drive through the landscape. Spring robotics is an introductory 4th grade robotics course. Students learn basic programming. Competition in the spring is done with the top 2 fifth grade robotics partners."[1]

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

- F59 met adequate yearly progress (AYP) in 2004-2005 and was not identified as in need of improvement for 2005-2006. F59 met AYP in 2005-2006, and has not been identified as in need of improvement. Tables 5 through 12 list the Standards Based Assessment (SBA) scores for grades 3 through 6 for each school.[3]
- "Using this NASA program, we have motivated students to learn, and have increased our TAKS scores in 5th grade."[1]

[3] The Great Schools website. The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 23, 2007 from http://www.greatschools.net/).

Table 1. F59 School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population			577	
Black, non-Hispanic			28	
Asian			11	
Hispanic			343	
Indian, Alaskan Native			0	
White, non-Hispanic			195	
School location (rural, suburban, urban, mid-size central city)			Large Central City	
School type (public, private, charter, magnet)			Public	
Title 1 status (yes or no)			Yes	
Free and reduced price lunch			52%	

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 17, 2007 from http://nces.ed.gov/ccd/bat/

Table 2. Summary of Academic Needs Identified by F59 in 2005

Priority	Discipline	Category	National Standard
1	National Science Education Standards	Physical Science	Light, heat, electricity and magnetism
2	Principles and Standards for School Mathematics	Measurement	Apply appropriate techniques, tools, and formulas to determine measurements
3	Standards for Technological Literacy	Design	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
4	National Science Education Standards	Life Science	Structure and function in living systems
5	National Science Education Standards	Life Science	Organisms and environments
6	National Science Education Standards	Earth and Space Science	Earth in the solar system
7	Principles and Standards for School Mathematics	Problem Solving	Build new mathematical knowledge through problem solving
8	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study
9	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the characteristics and scope of technology
10	Principles and Standards for School Mathematics	Communication	Communicate their mathematical thinking coherently and clearly to peers, teachers, and others

Source: F59 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that F59 Teachers Completed

NASA Explorer School summer content workshop on astrobiology (CA)
Staff development using GEMS materials provided at the NES summer content workshop on astrobiology
NCTM 2007 Annual Meeting and Exposition
2007 flight week reduced gravity opportunity
Winter Story Workshop
NSTA (Salt Lake City, UT)

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That F59 Teachers Incorporated into Their Instruction

DLN
Bubble festival kit and educator guide
NASA websites
NES Funding
NASA personnel/staff
NASA microgravity information and websites
Johnson Space Center
KSNN website
S'COOL website
Student Observation Network
NASA question
Website: http://son.nasa.gov/winterstory/data_entry_cc/index.php
Challenger Learning Center in San Antonio, TX
NASA website: Mars information
NASA exhibits, lessons, and activities
LEGO Robotics Kits
NASA website and profile videos

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. F59 TAKS Grade 3 Scores

	Reading	Writing	Math
2003			85%
2004	91%		92%
2005	93%		88%
2006	97%		81%
State Average in 2006	89%		82%

Source: TAKS Results. (2005-2006). Texas Dept. of Education. Downloaded 05-23-2007 from http://www.tea.state.tx.us/

Table 6. F59 TAKS Grade 4 Scores

	Reading	Writing	Math
2003	83%	91%	92%
2004	80%	92%	84%
2005	78%	85%	86%
2006	92%	97%	90%
State Average in 2006	82%	83%	83%

Source: TAKS Results. (2005-2006). Texas Dept. of Education. Downloaded 05-23-2007 from http://www.tea.state.tx.us/

Table 7. F59 TAKS Grade 5 Scores

	Reading	Science	Math
2003	82%		96%
2004	85%		80%
2005	89%		89%
2006	95%	84%	98%
State Average in 2006	80%	75%	81%

Source: TAKS Results. (2005-2006). Texas Dept. of Education. Downloaded 05-23-2007 from http://www.tea.state.tx.us/

NASA Explorer Schools Case Study Profile: G110
2005 Cohort—Large City, Arizona, Public Intermediate School: Grades 5-8

Summary Comments Regarding G110
G110 is a public, intermediate school located in Arizona that serves students in grades 5-8. The 2005-2006 school report card lists the student population as 714. The 2007 enrollment shows an increase in the number of Hispanic students to more than 80 percent; 94 percent of the student homes list Spanish as their primary language. One out of five of the G110 students are English language learners. The school is eligible for Title I benefits with 66 percent of the students qualifying for the free or reduced-price lunch program—exceeding the state average of 49 percent by 17 points. Table 1, posted at the end of the narrative, provides more details about G110 school demographics.

Here are some of the successes that G110 achieved during its three-year period as a NASA Explorer School:

- The school received useful resources from NASA for its students and families during special events and activities. The parents of G110 students have actively participated in school activities, and participation has increased over time.
- The NES team initiated activities to create schoolwide enthusiasm about being a NES school that included opening a mission patch contest to all students, holding a kickoff event, creating a huge mural featuring the winning mission patch in a school hallway, and hosting an astronaut visit. Teachers report that these startup activities generated pride and interest among the students.

As a school that serves a predominantly Spanish-speaking student population, G110 literacy issues precede STEM-G-related reform activities. Below is a description of challenges that the NES G110 team reported as factors that impeded their implementation of NES.

- Having two G110 NES team members on maternity leave caused continuity problems in terms of team roles and implementation of NES.
- Delay in receipt of NES funding led the team to put off some technology implementation for their students.
- Poor communication and lack of timely responses from the field center staff frustrated the team. The G110 team administrator created her own contact directory, but it was unclear which contact to call for specific needs. The NES program provided a notebook, but the G110 team found it too unwieldy and large.

- The G110 NES team experienced difficulty getting on the calendar to receive Aerospace Education Specialist (AES) services.
- Taking advantage of opportunities was sometimes difficult because of a disparity between the quick response required by the NES program and the actual time needed to get permission from the school district.
- The G110 NES team indicated that teacher buy-in has been a challenge. Teachers have a hard time thinking about how they are going to implement NASA resources in their classroom with some of the curriculum challenges that they have to address. The G110 NES team expects the Distance Learning Network (DLN) activities to provide a solution for this problem.
- Integrating NASA resources into the curriculum was extremely difficult for G110 teachers in grades 5-7 because their areas of academic concentration are math and reading, not science.

We examined schoolwide achievements at G110 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 transcript of a focus group interview conducted by telephone with the G110 NES team on May 5, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES G110 team was formed in 2004 with the team lead who teaches eight grade physical science, a math coach, a seventh grade science teacher along with another teacher and the school assistant principal. The NES G110 team stated that "the vision of the NASA Explorer Team is to increase interest in the disciplines of science, math, and technology as well as engineering and geography through space-related topics. We seek to generate an enthusiasm about space among students, teachers, and families that will result in a desire to be lifelong learners" (G110 Executive Summary, 2005). Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation G110 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. Tables 3 and 4 provide a summary of

the professional development opportunities and NASA resources that G110 has taken advantage of as a NASA Explorer School.

Guideline 1: Instructional Strategies.
This section looks for evidence that illustrates what kind of learning environments NES teachers at G110 created in their classroom using NASA activities. At the minimum level we asked teachers to describe whether they are using NES-provided materials to offer hands-on or cooperative learning activities. As the text below shows, it is not clear from the focus group interview with G110 team members what instructional strategies were applied when NASA activities were presented to students in the classroom.

> "Well, being a teacher, I definitely integrate [NASA activities] into my class, but then again, I'm a science teacher, so seventh and eighth grade are really the science teachers, so before that, you know, those kids aren't probably getting science everyday. I don't know, maybe they are, but probably not. They're focused on reading, writing, math, and it's very difficult to get teachers to take science and… use it in a math lesson. I think it's very difficult.… They do what they do everyday, and they've been doing it for years. So to get them to walk out of that and do something different, sometimes it's difficult.… They work well for me and if I have something to do on lunar phases or something…I can pull up stuff, I know exactly where to go, but that's very specific to my standards (Focus Group Interview, May 5, 2006).

In addition to our analyses from the case study, we report some key findings from the survey data on G110. These data shed new light on the results of the case study analyses and serve as data triangulation with our case study findings:

- When asked "How often do students in this class take part in doing hands-on/laboratory activities?" teachers responded differently. One teacher responded "sometimes," one said "1-3 times per month," and another responded "almost everyday" in the Teaching, Learning, and Computing (TLC) survey.
- When asked "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 teacher responded "1-3 times per month"; one, "1-3 times per week"; and another, "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: One teacher responded "sometimes," and another responded "often."
  - Get students to justify and explain their reasoning: One teacher responded "often," and another responded "very often."
  - Have students relate what they are working on to their own experience: One teacher responded "often," and another responded "very often."
- When asked "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 Needs and Involvement survey, one teacher responded "a lot," one said "quite a bit," and one responded "a little."

Guideline 2: Time Intensive.

Teachers described how they benefited from being able to attend national, regional, and NASA-sponsored professional development conferences and workshops. The quotes below describe the kind of professional development experiences that the G110 teachers recalled and their overall increased interest in space science that resulted from the series of NES teacher training opportunities.

- "I think the opportunity for them to attend the national conferences and to be trained by the AESP…I think it did benefit them definitely in that way" (Focus Group Interview, May 5, 2006).
- "Personally, it's increased my own personal interest in the space program, especially spending the week out at Dryden. I mean that really has increased my interest in flight and space in general" (Focus Group Interview, May 5, 2006).
- "I found out about this grant because I'm in another group in NASA. That's … how I know about this grant, and this grant opened up other opportunities for me, so that's probably what it's done for me personally" (Focus Group Interview, May 5, 2006).
- Videoconferencing/DLN Training: "Teachers will participate in a staff development to learn how to use videoconferencing in their classrooms. We will be able to connect using our videoconferencing equipment to do this" (e-Folio, 2007).
- NSTA national conference, St. Louis: "This was a national science teachers conference. We had a NASA update dinner where participants in NES received news about the program. We also had a luncheon which included speeches by prominent astronauts and educator astronauts. The symposium that I attended was *Living in a Space Habitat*. It had activities to try and create a habitat somewhere else other than Earth. We received background on what [a space habitat] might look like before we started.

> We also had several guest speakers that helped us along the way. Many teachers have been communicating since through e-mail" (e-Folio, 2007).

The NES G110 team administrator described how participation in professional development opportunities targeted for administrators has helped her/his professional development by providing expanding opportunities to communicate with other administrators.

- "The administrative training that I always go to is the National Middle School Association Conference in Philadelphia.…There were a lot of ideas and a lot of sharing of ideas, so we didn't have to create necessarily. We just had to make the connections once we got back to Phoenix" (Focus Group Interview, May 5, 2006).
- "They were both NASA trainings, the summer training and…the NES administrators training along with the national conference that you selected…As the administrator on the team, I just found it to be very beneficial to hear what other administrators are doing and …how they go about supporting the team. You're in kind of a specialized role in the sense of what your duties are at the school. It's a pretty isolated role if you're an administrator, and so to be able to meet with other administrators anytime…you really grow professionally, both with NASA and also as an administrator in general" (Focus Group Interview, May 5, 2006).

Guideline 3: Classroom Practices.

Teacher responses on the NES Teacher Involvement survey completed in spring 2006 are summarized here to triangulate the focus group interview data. Teachers report less integration of career education activities, but "quite a bit" of space science, inquiry methods, and technology into their classroom instruction. The data show that one G110 teacher integrated some NASA career activities into his/her classroom teaching, while three teachers indicated that they integrated little to none of the career education activities. In terms of technology use for classroom instruction and teacher use of technology, the G110 team reports much more integration with all reporting some integration of technology (for both uses), and most reporting quite a bit to a lot of integration of instructional technologies.

The teacher quotes below illustrate how G110 teachers describe they have integrated NASA resources and expertise into their curriculum:

- "Just renewing [interest in] wanting to teach and have activity-based learning in the classroom...When you have been teaching for several years…going to Dryden and experiencing what I experienced and getting excited again about bringing it to the students" (Focus Group Interview, May 5, 2006).
- Videoconferencing/DLN Training: "Teachers will participate in a staff development to learn how to use videoconferencing in their classrooms. We will be able to connect using our videoconferencing equipment to do this" (e-Folio, 2007).
- NSTA National Conference, St. Louis: "This was a national science teachers conference. We had a NASA update dinner where participants in NES received news about the program. We also had a luncheon which included speeches by prominent astronauts and educator astronauts. The symposium that I attended was *Living in Space: Habitat*. It had activities to try and create a habitat somewhere else other than Earth. We received background on what that might look like before we started. We also had several guest speakers that helped us along the way. Many teachers have been communicating since through e-mail" (e-Folio, 2007).

In addition to our observations from teacher focus group interviews and the NES e-Folio, we also sought out key findings from the Teacher Needs and Involvement survey on how much NES G110 teachers anticipate the following in their instruction:

- Align NASA STEM-G resources to national, state, or district standards: Two teachers responded "a little," and one responded "quite a bit."
- Integrate more space science into my instruction: Two teachers responded "a lot," and one responded "a little."
- Integrate more technology into my instruction: One teacher responded "a lot," one responded "quite a bit," and one responded "a little."
- Integrate more geography into my instruction: One teacher responded "some." one responded "a little," and one responded "not at all."
- Incorporate more technology into my instruction: One teacher responded "a lot," one responded "quite a bit," and one responded "some."
- Integrate more engineering into my instruction: Two teachers responded "a little," and one responded "not at all."
- Incorporate more STEM-G career information into my instruction: All three teachers responded "some."

Guideline 4: Content Knowledge.

G110 team teachers felt that they became more comfortable teaching math, educational technology, and science concepts as a result of their participation in the NES program. However, the team expressed less comfort with teaching engineering, technology education, robotics, and geography concepts:

- "Just [to] increase the student knowledge because we are going to be tested statewide on their science knowledge and hold us accountable for knowing science, so that's another one of our goals. We're hoping this will increase the teacher's knowledge and, therefore, eventually trickle down to the students" (Focus Group Interview, May 5, 2006).
- "We had an AES come for one of our after-school training sessions and give the teachers some experience with some of the activities that are in the learning modules, the units. We also had a family fun night. We did two of them that were space oriented. One was in the fall. We had a local astronomer—he goes by the fun name of Dr. Sky—and he came with a telescope, so students who came in and their parents were able to look at different heavenly bodies, if that's what it's called. Also, when we had our kick-off, we had our family night, so the astronaut presented a lot of slides, PowerPoint of his recent trip on the space shuttle to the space station, and we had a lot of good parents and students coming for that evening event" (Focus Group Interview, May 5, 2006).
- National Middle School Conference: "They showed us opportunities for both teachers and students. We did an activity where we made a glider, and we talked about how to incorporate NASA into all subject areas. We attended two math sessions for the rest of the day. On Friday we attended a technology, an assessment, Kay Toliver session. On Saturday we attended two math sessions" (e-Folio, 2007).

In addition to our observations from teacher focus group interviews and the NES e-Folio website, we also sought key findings from the Teacher Needs and Involvement survey on how comfortable teachers currently are teaching concepts in each of the following areas:

- Science: Two teachers responded that they have "a lot" of comfort teaching science concepts now, one responded "quite a bit," and one responded "some" comfort.
- Educational technology: Two teachers responded that they have "a lot" of comfort teaching educational technology concepts now , one responded "quite a bit," and one responded "a little."
- Engineering/Technology Education/Robotics: Two teachers responded that they have "some" comfort teaching engineering concepts now, and two others responded "a little."

- Mathematics: Two teachers responded that they have "a lot" of comfort teaching mathematics concepts now, one responded "quite a bit," and one responded "some."
- Geography: Only one teacher responded that he/she has "a lot" of comfort teaching geography concepts, while others responded "not at all," "a little," and "some."

Guideline 5: Active Learning.
The spring 2006 interview with the G110 NES team included these references to teachers presenting, leading, or writing about how they connect their work to specific standards for student performance. The team mentioned several times that their primary focus is reading and math skill development. They also mentioned that science is not a regular part of the school curriculum until seventh grade.

- "We were most effective when we met every week. But we can't always meet every week" (May 6, 2006).
- "DLN will be neat and helpful. They need something the teachers can use in the classroom. They need more [material] for standards (like Earth Science). They need to get good lessons the teachers can use" (May 6, 2005).
- "Using NASA resources, teachers will learn how to use these resources in their classrooms to meet state standards" (e-Folio, 2007).
- "I can pull up stuff. I know exactly where to go, but that's very specific to my standards" (Focus Group Interview, May 5, 2006).

Guideline 6: Coherence.
The G110 team took advantage of NES opportunities to participate in national professional conferences, which will help support sustained professional development and teacher growth. The team discussed doing monthly teleconferences with "sister" NES schools, but there is no documentation that these teleconferences occurred or for how long or what the discussions entailed. There is no evidence of G110 building relationships with feeder schools or leveraging NES funds to pursue additional partnerships. The team lead reports in the 2006 spring survey that having community support is a very important part of the program and that local businesses have provided support for the program:

- In response to a question regarding whether goals and objective for NES are aligned with the school improvement plan, the G110 team teacher replied, "I had to make our individual goals and our strategic plan and our implementation plan.... We have many improvement plans and things

going on so…those [school improvement plans] are aligned to our goals that we chose for this year" (Focus Group Interview, May 6, 2006).

- "There's a plethora of resources, and we just have been always able to find something that meets our needs" (Focus Group Interview, May 6, 2006).
- National Middle School Conference: "They showed us opportunities for both teachers and students. We did an activity where we made a glider, and we talked about how to incorporate NASA into all subject areas" (e-Folio, 2007).

Here is a summary of G110 team leader's responses to key questions on the Team Lead survey that we compare with verbal team responses during the telephone interview. The team lead expressed being "very satisfied" with the following components of the NES project: involvement of the administrator team member, NASA staff assistance with implementation plan, NES team teacher use of technology, NES team teacher use of inquiry, use of implementation plan, and stability of the NES team. The team lead reported that the team is "not at all and somewhat satisfied" with use of videoconferencing, use of DLN, development of community partnerships, NASA staff assistance in planning for sustainability, and communication with NASA staff. The problems identified in the team lead survey were also described in the telephone interview with the full team. Many of these challenges are highlighted in the beginning of the case study report.

Summary of How G110 Meets Outcome 1.

G110 uses NASA Explorer Schools' opportunities and resources to supplement activities that support their school improvement plan (see Tables 3 and 4 for details). Team members have selectively chosen resources to support activities and curriculum to increase student content knowledge and to pique student interest in STEM-G subjects. Professional development through conferences and on-site training provide content knowledge and instructional strategies for the teachers. The process has been relatively easy for the G110 team, but has been more difficult for G110 non-team teachers. The G110 team expects to remedy this by building excitement and encouraging participation of non-team members through use of the Distance Learning Network as well as by providing more classroom resources that are aligned with standards for science and demonstrations of lessons that can be used in the classroom without spending a lot of money.

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

The G110 team technology purchases support plans to increase professional development for teachers and learning opportunities for students through the Digital Learning Network. The purchase of a quality telescope and accessories supports plans to integrate space science into the curriculum.

The G110 team purchased the following technologies with NES funding:

- Ohaus Compact Balance Model CS2000
- Videoconferencing system Model 880 MXP
- Portable document camera
- SkyviewnPro 9.25 XLT Schmidt-Cassegrain Telescope
- Polar Axis Founder Scope
- Drive system
- Anti-vibration pads
- Plossl eyepieces
- 2x Barlow lens
- Filter set
- PowerZone software and starter kit and CDs

The G110 team reports more confidence using instructional technology in their spring 2006 Teacher Involvement survey, but they also report no use of DLN then.

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

In the spring 2006 team lead survey the G110 team reports that the family nights coordinated by the G110 team provided activities with new information on a weekly basis. In all other areas the team lead reported that activities were shared with parents about 3-6 times per year:

- "We ran off a couple of the newsletters for family involvement, but we didn't do that as much as we needed to. I didn't do that as much as I needed to. So that's certainly something that we need to do next year, to get some of those formalized communications that NASA makes available to us, get those out to the classrooms so that they can use them" (Focus Group Interview, May 5, 2006).

- "…the resources, and especially the parent nights has really, I'm surprised. Those were our greatest successes for the first year" (Focus Group Interview, May 5, 2006).
- "When the AESP person came out, both for the kickoff and also for the staff development, that was wonderful support. And anytime NASA, for the kickoff, any of the people who were visiting, they were just more than willing to go into the classroom, to meet with the kids. It included a very long day from the kickoff in the morning to the parent meeting in the evening, and the astronaut was willing to do as much as anyone else, so really, that was a great event, and that support was really well received by the parents and the students and teachers" (Focus Group Interview, May 5, 2006).
- Family Fun Night: "Families will participate in an activity to determine how long it would take to get to the moon via different modes of transportation—walking, bicycling, 737 jet, Apollo 11 spacecraft, space shuttle. Students will use calculators to complete a spreadsheet of formulas" (e-Folio, 2007).
- Family Career Night: "Students and families will find out more about careers available at NASA and what schooling they will need to have to do that job" (e-Folio, 2007).

Searching for postings about G110 outreach and family events on the web, we found the following comments from parents of G110 students.

- "Unorganized school. They don't follow their own school calendar" (June 2006).

- "As a personal experience, I have an ADD child, and the school and principal [have] been a best help for both of us. It's been 2 years since he got diagnosed, and the school help[s] him a lot with this....Thank you [G110]"(October 2005).

- "They need a better pick-up and drop-off routine"(August 2005).

- "I would recommend this school to any parent. The teachers are very positive. I try to work well with the parents so your children have the chance to succeed" (July 2005).

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

The G110 NES team has leveraged the excitement and pride of being involved with NASA to draw the student population into the NES program. The team created schoolwide involvement from the beginning by holding a mission patch competition, creating a highly visible space mural, and bringing an astronaut to G110 to interact with the students early in the implementation.

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.

Noticeable curiosity in STEM-G topics and events,

- "We kicked off with a mission patch for the school. We had the art teacher really integrate with us and come up with kids that did some art mission patches and then we chose one. There's a mural of it in the front. There's actually a whole huge space mural now in our school. We had a kick-off, actually had an astronaut, that was really a big deal for a lot of students. They got to ask him questions" (Focus Group Interview, May 5, 2006).
- Snaky Poetry: "Students will read Snakebots, a non-fictional text about snake-like robots, and write a short triangular triplet poem about snakebots" (e-Folio, 2007).

Changes in self-concept.

- "Also, its really, I don't think this has been mentioned yet, maybe it'll fit a little bit later but, it has really built some school pride through NASA, the mission patch competition and then carrying that out by making a mural and setting a scene. It creates the overall pride and really changed the culture among the students as far as being proud to go to G110 because it is a NASA Explorer School" (Focus Group Interview, May 5, 2006).

Attitudes changes about learning.

- "Our mural project actually sparked another mural that went into the hallways, the hallways looked pretty much remarkably different, they were kind of white and boring and I know that the students really thought they were neat, that an honors art class that did it this year, we never had that before, art?" (Focus Group Interview, May 5, 2006).
- "I would say overall that it [the NES program] has impacted all the students definitely, just by the kickoff and the murals, because it is in the front entryway. It really does set the tone of the whole school. The others

are probably their main impact is in, based on the fact that it's kind of changed the culture of the school" (Focus Group Interview, May 5, 2006).

Outcome 5. Increased student knowledge about careers in STEM-G.

The interest of students at G110 was sparked by a visit from a real NASA astronaut. The students were able to ask questions and interact with the astronaut during the visit.

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

Increase understanding of and enthusiasm about STEM-G careers.

- "We had a kickoff, actually had an astronaut, that was really a big deal for a lot of students. They got to ask him questions" (Focus Group Interview, May 5, 2006).
- Challenger Space Center Missions: "Each of the six fifth grade classes will visit the Challenger Learning Center and participate in a mission: Voyage to Mars or Rendezvous with a Comet. Prior to the mission, each will participate in a minimum of 20 lessons focusing on the science for the mission and the different jobs that the students will role play" (e-Folio, 2007).
- Volcanoes from the Sky: "Mount Rainier is an active volcano in the Cascade Range. During the past eruptions large mudflows resulted. If similar mudflows occurred in the future, would people be in danger? Students will determine this" (e-Folio, 2007).
- Shake the Earth: "Students will use longitude and latitude to plot earthquake data from 2002. They will also use color to indicate the earthquake's magnitude. They will then plot earthquake data from today using a website from USGS that lists current earthquake data (e-Folio, 2007).
- Family Career Night: "Students and families will find out more about careers available at NASA and what schooling they will need to have to do that job" (e-Folio, 2007).

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

G110 is acutely aware of its need to improve standardized test scores (AIMS). As shown in Tables 5-8, G110 scores have been below the state average scores from 2003 to 2005. The 2006 AIMS scores show that there has been slight improvement for grade 7 in writing and math and for grade 8 in reading, writing, and math. Grade 5 has dropped in all three subject areas. However, grade 6 has made tremendous improvement with a 12 percent increase in reading scores, a 34 percent increase in writing scores, and a 17 percent increase in math scores, which puts them higher than the state average in all three subject areas.

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

- Challenger Space Center Missions: "Each of the six fifth grade classes will visit the Challenger Learning Center and participate in a mission: Voyage to Mars or Rendezvous with a Comet. Prior to the mission, each will participate in a minimum of 20 lessons focusing on the science for the mission and the different jobs that the students will role play" (e-Folio, 2007).
- Volcanoes from the Sky: "Mount Rainier is an active volcano in the Cascade Range. During the past eruptions large mudflows resulted. If similar mudflows occurred in the future, would people be in danger? Students will determine this" (e-Folio, 2007).
- Shake the Earth: "Students will use longitude and latitude to plot earthquake data from 2002. They will also use color to indicate the earthquake's magnitude. They will then plot earthquake data from today using a website from USGS that lists current earthquake data (e-Folio, 2007).

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

- Digging for Dinosaurs on the Web: "Students will read 'No Bones About It' and informational text selection and then do a web search in the computer lab to find interesting facts about the Mesozoic and dinosaurs" (e-Folio, 2007).
- Shake the Earth: "Students will use longitude and latitude to plot earthquake data from 2002. They will also use color to indicate the earthquake's magnitude. They will then plot earthquake data from today using a website from USGS that lists current earthquake data (e-Folio, 2007).
- Family Fun Night: "Families will participate in an activity to determine how long it would take to get to the moon via different modes of transportation—walking, bicycling, 737 jet, Apollo 11 spacecraft, space

shuttle. Students will use calculators to complete a spreadsheet of formulas" (e-Folio, 2007).

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

The NES teachers and administrators at G110 are aware of increased pressure to improve student achievement scores. G110 did not meet its No Child Left Behind annual progress goals in the 2005-2006 school year.

- "We are going to be tested statewide on their science knowledge and [they will] hold us accountable for knowing science, so that's another one of our goals. We're hoping this will increase the teachers' knowledge and, therefore, eventually trickle down to the students" (Focus Group Interview, May 5, 2006).

Table 1. School Demographics

	2003-2004	2004-2005	2005-2006	2006-2007
Student population	675*	668*	NA	NA
Black, non-Hispanic	9%*	7%*	8%**	NA
Asian	Less than 1%*	Less than 1%*	<1%**	NA
Hispanic	71%*	77%*	81%**	NA
Indian, Alaskan Native	2%*	2%*	1%**	NA
White, non-Hispanic	17%*	13%*	9%**	NA
School location (rural, suburban, urban, mid-size central city)	NA	Large City*	NA	NA
School type (public, private, charter, magnet)	NA	Public*	NA	NA
Title 1 status (yes or no)	NA	Yes*	NA	NA
Free and reduced price lunch	NA	79%*	66%**	NA

* National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 2, 2007, from http://nces.ed.gov/ccd/bat/

** The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 2, 2007, from http://www.greatschools.net/

Table 2. Summary of Academic Needs Identified by G110 in 2005

Priority	Discipline	Category	National Standard
1	National Science Education Standards	Earth and Space Science	Objects in the sky
2	National Science Education Standards	Earth and Space Science	Earth in the solar system
3	National Science Education Standards	Life Science	Characteristics of organisms
4	National Science Education Standards	Earth and Space Science	Changes in earth and sky
5	National Science Education Standards	Physical Science	Motions and Forces
6	Principles and Standards for School Mathematics	Algebra	Understand patterns, relations, and functions
7	Principles and Standards for School Mathematics	Algebra	Analyze change in various contexts
8	Principles and Standards for School Mathematics	Connections	Recognize and use connections among mathematical ideas
9	Principles and Standards for School Mathematics	Data Analysis and Probability	Select and use appropriate statistical methods to analyze data
10	Principles and Standards for School Mathematics	Measurement	Apply appropriate techniques, tools, and formulas to determine measurements

Table 3. NASA Professional Development Opportunities that G110 Teachers Completed

NES orientation workshop
National conferences
NES administrator training
National Middle School Association conference (Philadelphia)
NES sustainability conference
AES on-site training
NSTA national conference (St. Louis)

Table 4. NASA Resources and Expertise That G110 Teachers Incorporated into Their Instruction

NASA funding [travel & conference fees]
NASA personnel (astronauts, Dr. Sky, AES)
Challenger Space Center missions
Voyage to Mars curriculum
NASA Explores: No Bones About It
NASA Explores: Digging for Dinosaurs on the Web
NASA Explores 5-8 lesson: Volcanoes in the Sky
NASA Explores: Snakebots
NASA Explores: Snaky Poetry
NASA Explores: Shake the Earth
Lunar samples

Table 5. G110 AIMS Grade 5 Scores

	Reading	Writing	Math
2003	46%	53%	35%
2004	39%	64%	37%
2005	60%	60%	70%
2006	54%	43%	62%
State Average in 2006	74%	62%	74%

Source: AIMS Results. (2005-2006). Arizona Dept. of Education. Downloaded May 1, 2007, from http://www.ade.state.az.us/

Table 6. G110 AIMS Grade 6 Scores

	Reading	Writing	Math
2003	-	-	-
2004	-	-	-
2005	50%	50%	44%
2006	62%	84%	71%
State Average in 2006	68%	71%	68%

Source: AIMS Results. (2005-2006). Arizona Dept. of Education. Downloaded May 1, 2007, from http://www.ade.state.az.us/

Table 7. G110 AIMS Grade 7 Scores

	Reading	Writing	Math
2003	-	-	-
2004	-	-	-
2005	59%	70%	81%
2006	55%	91%	75%
State Average in 2006	72%	92%	73%

*Source: AIMS Results. (2005-2006). Arizona Dept. of Education. Downloaded May 1, 2007, from http://www.ade.state.az.us/

Table 8. G110 AIMS Grade 8 Scores

	Reading	Writing	Math
2003	40%	31%	6%
2004	35%	65%	15%
2005	57%	76%	55%
2006	58%	82%	57%
State Average in 2006	69%	83%	65%

Source: AIMS Results. (2005-2006). Arizona Dept. of Education. Downloaded May 1, 2007, from http://www.ade.state.az.us/

NASA Explorer Schools Case Study Profile: H6
2005 Cohort—Urban, Maryland, Public Elementary School: Grades PK-7

Summary Comments Regarding H6
H6 is an urban public elementary school located in a large city in Maryland. The school serves grades PK-7, with plans to add grade 8 by 2008. The student population is nearly 100 percent African American. On average 90 percent of H6 students are eligible for free or reduced lunch. H6 receives Title I schoolwide services. Students are considered at-risk due to several factors, including the school location in an area of high crime and high poverty, a high rate of adult illiteracy and one parent or absentee parent households. H6 became a Charter School with [University] as the operator in August 2006. H6 made adequate yearly progress in 2004-2005. The state Department of Education did not identify this school as in need of improvement for 2005-2006.1 As a result of this new initiative, H6 was removed from the state's reconstitution-eligible list, due to the gains made on the present State's standards.[1]

Here are some of the successes that H6 achieved during its three-year period as a NASA Explorer School:

- H6 has developed partnerships with Coppin State University, US Fish & Wildlife, Maryland Foundation, Chesapeake Bay Foundation, and "Adopt-a-Pilot" program of Southwest Airlines to teach science, technology, and math in creative and challenging environments.
- H6 has become a model of achievement for inner city public schools as a result of its strong leadership, committed teachers, and parental and community involvement.
- H6 student mathematics achievement scores at two grade levels exceeded state averages.

As a school that serves a predominantly poor population, H6 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- Late arrival of funds was a challenge for the H6 NES team. They had to delay the purchase of materials and limit activities until the money arrived. Parents helped with fundraising to compensate.
- In regard to online surveys, H6 would have liked to have the ability to start, pause, and return to the surveys. Having only two computer labs limited their ability to take the online surveys. Teachers completed some of the surveys outside of school hours.

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[1] Source: MSDE, 2005-2006

- Professional development days promised by the school board were taken back. The team overcame this challenge by doing professional development during team meetings or by having the team lead meet with H6 faculty and students.

We examined schoolwide achievements at H6 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 transcript of a focus group interview conducted by telephone with the H6 NES team on May 18, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES H6 team was formed in 2005 with five members: school administrator, grades 3-6 teacher, team lead/technical person, informal educator/special educator, and instructional support teacher for early learning years. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation H6 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 NASA kickoff, professional mentoring of students, Parent Technology Night, Parent Workshops with NASA and the wildlife department, 2006 Student Symposium, joint staff development activity with Goddard Space Flight Center and Patuxant Wildlife Visitor Center, trip to the Air and Space Museum, and students attended the North Bay Environmental Camp. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that H6 has taken advantage of as a NASA Explorer School.

The next section examined the extent to which the H6 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

- "It is a good way to get more hands-on science, get the kids excited by science in a real way instead of just by textbook" (Focus Group Interview, May 18, 2006).
- "Learning more about what NASA meant how to use it in a school and with young children" (Focus Group Interview, May 18, 2006).

- "This is valuable to me so I support the activities. Anything that will make a difference in the success of the children is important to me. Teamwork, completing projects, new experiences where the children come back so excited and what they have done and consequently they are excited about school. This gives us increased attendance and increased interest. It helps us meet AYP (adequate yearly progress)" (Focus Group Interview, May 18, 2006).
- "Team building-we look forward to getting together, being together, and doing things together. It has modeled team building and cooperation" (Focus Group Interview, May 18, 2006).
- "It has opened my eyes to what NASA provides for children, exposure for careers and resources. The hands-on activities are so important. I look forward to people coming for more staff development. It increases our level of knowledge and increases our techniques in teaching and that gets passed along to the students" (Focus Group Interview, May 18, 2006).
- "We get more media attention because of NES. We have been in the paper, on all three local television stations, and have many visitors who come to see what we are doing. It makes the teachers and students proud. It is positive attention – something that Baltimore schools do not often get. You wouldn't believe the waiting list I have of teachers that want to work at [H6]" (Focus Group Interview, May 18, 2006).
- "We believe in reading across the curriculum. A science lesson is an opportunity to teach reading" (Focus Group Interview, May 18, 2006).
- "We look very much like a private school. Our teachers infuse the space and content standards into the music and art" (Focus Group Interview, May 18, 2006).
- "The children and teachers wear uniforms to school. The children are well-behaved. The teacher uniforms started as a gift of a shirt at Christmas. This gift has become a tradition. (Mon-white shirt/blue pants; Tue-indigo blue shirt; Wed-navy shirt/khaki pants; Thu-red shirt; Fri-different red shirt)" (Focus Group Interview, May 18, 2006).
- "Students at H6 are given a variety of opportunities to be involved in clubs that relate to STEM-G learning areas. Two of the most popular clubs are the environment and habitat club and the tech kids technology club. This activity is to build on the students and staffs interest and knowledge of STEM-G subjects in a non-traditional classroom setting."[2]

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[2] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007, from http://aesp.nasa.okstate.edu/efolio

- "The National Middle School Association Annual Conference was held in Nashville, Tennessee on the dates of November 1-4, 2006. Participants in the conference selected from a variety of sessions related to middle school education. Topics included advisory, classroom management, instructional strategies, and tools for differentiating instruction among others."[2]

In addition to our analyses from the case study, we report some key findings from the survey data on H6. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often students in this class take part in hands-on/ laboratory activities, one teacher said "almost everyday," two responded "1-3 times per week," one responded "1-3 times per week," and one said "sometimes" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often students in this class take part in working in small groups to come up with joint solutions or an approach to a problem or task, two teachers responded "almost everyday," one said "1-3 times per month" and two said "sometimes" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often the teachers accomplish the following goals:
    - Elicit students' ideas and opinions: One teacher said "always" while three responded "very often," "often," and "sometimes."
    - Get students to justify and explain their reasoning: One teacher said "always" while the other three responded "very often," "often."
    - Have students relate what they are working on to their own experience: Two teachers said "always," two responded "very often," and one said "often."
- When asked in the Teacher Involvement survey how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, only one teacher responded "quite a bit," one said "some," and three said "a little."

Guideline 2. Time Intensive.

- "Our team name is Deep Impact. As you can see, we work well together. We used our expertise to combine our abilities. We confide in each other and talk to each other. Having the principal on the team has helped" (Focus Group Interview, May 18, 2006).
- "We took the online survey to determine student interest; we identified science magazines to purchase through NSTA; we contacted TV stations about having students do the weather (we had one student do this

already), two teachers attended an ozone monitoring workshop" (Focus Group Interview, May 18, 2006).

- "We take advantage of trips that are offered to us to enhance ourselves" (Focus Group Interview, May 18, 2006).
- Three H6 teachers attend the NASA Astrobiology Workshop. "A weeklong workshop held at the [Field Center B] . Scientists, NASA Officials, and Presenters worked with members of our NES team to gain content knowledge and practical activities that could be used in the classroom."[2]
- One H6 teacher attended the National Council for Geography Education Annual Meeting. "The National Council for Geography Education gave some great insights into how to use geography as a means of teaching about Earth science, land formation, living organisms, etc. Many of the activities were directly transferable into a classroom context and help us in increase STEM-G education within the school building."[2]
- H6 teachers (5 team members and 45 non-team members) attended a staff retreat at the National Conservation Training Center. "As a staff we will go to the National Conservation Training Center to learn about environmental education, complete team building activities, and explore ways to expand STEM-G learning within the school building."[2]
- "The National Middle School Association Annual Conference was held in Nashville, Tennessee on the dates of November 1-4, 2006. Participants in the conference selected from a variety of sessions related to middle school education. Topics included advisory, classroom management, instructional strategies, and tools for differentiating instruction among others. NASA Explorer School participants were invited to attend two sessions specific to the role NASA plays in supporting its partner schools. During these meetings, we learned that NASA provides the equivalent of $17,500 per year over a three year period to integrate science and technology into the classroom. The National Middle School Association Annual Conference gave us some great insights into a population we are trying to grow at our school. We have been adding an extra grade to our K-5 elementary school each year as we move to make [H6] a true elementary/middle school."[2]
- H6 attendance at the National Educational Computing Conference (NECC) scheduled for June 2007 was postponed. "Because of conflicts with the [H6] Summer School program this conference will not be attended until 2008."[2]

Guideline 3. Classroom Practices.

- "We had our kickoff in October with NASA people (an engineer and NASA officials attended); we showed a film on what it is to be an astronaut; we did robotics and aeronautics activities for student with our AES; we integrate our NASA materials with art, music and special activities; we entered the music competition; we display student art throughout the building. For careers we made a DVD, attended two Imax movies; we go online; our students are mentored by several organizations (Black Engineers Conference, Alpha Psi Alpha for girls; Alpha Ki Alpha for boys, Coppin State University mentors our talented students)" (Focus Group Interview, May 18, 2006).
- Three H6 teachers attend the NASA Astrobiology Workshop. "A weeklong workshop held at the [Field Center B] Scientists, NASA Officials, and Presenters worked with members of our NES team to gain content knowledge and practical activities that could be used in the classroom."[2]
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Guideline 4. Content Knowledge.

- "I have gotten more information and exposure to STEM-G activities and contextual knowledge. It provides another level for the students" (Focus Group Interview, May 18, 2006).
- Three H6 teachers attend the NASA Astrobiology Workshop. "A weeklong workshop held at the [Field Center B] Scientists, NASA Officials, and Presenters worked with members of our NES team to gain content knowledge and practical activities that could be used in the classroom."[2]
- One H6 teacher attended the National Council for Geography Education Annual Meeting. "The National Council for Geography Education gave some great insights into how to use geography as a means of teaching about Earth science, land formation, living organisms, etc. Many of the activities were directly transferable into a classroom context and help us in increase STEM-G education within the school building."[2]
- "Students at H6 are given a variety of opportunities to be involved in clubs that relate to STEM-G learning areas. Two of the most popular clubs are the environment and habitat club and the tech kids technology club.

This activity is to build on the students and staffs interest and knowledge of STEM-G subjects in a non-traditional classroom setting."[2]

- One H6 teacher attended the National Science Teachers Association (NSTA) Area Conference. "The National Science Teachers Association Area Conference was held on December 6-9, 2006 in Salt Lake City, Utah. Attendee went to different workshops and presentations associated with three strands including Using Science to Teacher Language Literacy and Mathematics, The Nature of Science: What is Science?, and Putting Science Education Research into Action. NASA Explorer School teachers were invited to IPY/NSTA Symposium: The Fragile Ice, where teachers learned how to teach and explain the importance of the earth's polar ice. The National Science Teachers Association Conference did a good job introducing new science activities that could be used in the classroom. The NASA sessions were particularly helpful in showing how Distance Learning can be used to increase student interest in science."[2]

Guideline 5. Active Learning.

- "We were shaping our own expectations – what our staff and students needed" (Focus Group Interview, May 18, 2006).
- "[Name1], [Name2], [Field Center H] coordinator and others have been very helpful. They brought models of the ISS, solar system, Hubble telescope, and a space suit. They arranged for an astronaut visit" (Focus Group Interview, May 18, 2006).
- "When educators worked with teachers they brought grade-level activities and hands-on materials to use" (Focus Group Interview, May 18, 2006).
- "We use the voluntary state curriculum and try to connect NASA information and STEM-G to it" (Focus Group Interview, May 18, 2006).
- H6 teachers (5 team members and 45 non-team members) attended a staff retreat at the National Conservation Training Center. "As a staff we will go to the National Conservation Training Center to learn about environmental education, complete team building activities, and explore ways to expand STEM-G learning within the school building."[2]
- One H6 teacher attended the International Technology Education Association (ITEA) Annual Conference in San Antonio, TX. "The conference was very interesting and presented new ways to incorporate STEM-G related learning into the classroom."[2]

Guideline 6. Coherence.

- "We have increased partnerships and made them aware of NES (including Coppin State University, U.S. Fish & Wildlife, Maryland … Foundation, Chesapeake Bay Foundation, "Adopt-a-Pilot" with Southwest Airlines).

We get everyone involved in STEM-G activities. We include parents in every activity at [H6]" (Focus Group Interview, May 18, 2006).

- "We had our kickoff in October with NASA people (an engineer and NASA officials attended); we showed a film on what it is to be an astronaut; we did robotics and aeronautics activities for student with our AES; we integrate our NASA materials with art, music and special activities; we entered the music competition; we display student art throughout the building. For careers we made a DVD, attended two Imax movies; we go online; our students are mentored by several organizations (Black Engineers Conference, Alpha Psi Alpha for girls; Alpha Ki Alpha for boys, Coppin State University]mentors our talented students)" (Focus Group Interview, May 18, 2006).
- "Our goal is to exceed the sole proficiency in all areas as measured by the state assessment. We are delighted that we have become a NASA Explorer School and have extensive plans to infuse NASA content in all facets of the curriculum where appropriate. It is our hope it will motivate and teach students using STEM-G and the Volunteer State Curriculum. H6 also has a highly effective partnership with U.S. Fish and Wildlife and plans are being generated where the experiences from the two partnerships will be combined to increase student achievement."[2]
- "As a New Charter School with [University], the University will assist in maintaining the technology infrastructure, purchasing new updated software and assisting [H6] to achieve the NASA goals."[2]
- "NASA Explorer School participants were invited to attend two sessions specific to the role NASA plays in supporting its partner schools. During these meetings, we learned that NASA provides the equivalent of $17,500 per year over a three-year period to integrate science and technology into the classroom. The National Middle School Association Annual Conference gave us some great insights into a population we are trying to grow at our school. We have been adding an extra grade to our K-5 elementary school each year as we move to make [H6] a true elementary/middle school."[2]
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> invited to IPY/NSTA Symposium: The Fragile Ice, where teachers learned how to teach and explain the importance of the earth's polar ice. The National Science Teachers Association Conference did a good job introducing new science activities that could be used in the classroom. The NASA sessions were particularly helpful in showing how Distance Learning can be used to increase student interest in science."[2]

Summary of How H6 Meets Outcome 1:
H6 has successfully managed to integrate many NASA resources into their curriculum to promote students' STEM-G learning. Exposure to hands-on activities provided by NASA has excited teachers to become more creative in their teaching. H6 credited the success of NES to team coordination and support. Through the workshops, teachers learn content knowledge as well as practical activities to implement in their classrooms. Attending conferences has helped teachers learn innovative ways of teaching. The AES also brought grade-level and hands-on activities to help other H6 teachers implement STEM-G activities into their curriculum.

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

The H6 team purchased the following technologies with NES funding:

- Tandberg video conference equipment/server/cable
- Toshiba PC Tablets
- Toshiba Data Projector
- Interactive WhiteBoard accessories (styluses, erasers, USB audio system)
- Apple wireless router
- Kodak digital camera
- 60 MB hard drive
- LEGO Mindstorm robotics kits
- Robolab software
- 25 ft. of cat 5 cables
- PNY 512 MB flash drives

The partnership with NES and Coppin State University has helped H6 teachers become more technology literate. NES funding provided the school with new technology hardware, and the local university provided on-site technology infrastructure support.

- "It increased my use of technology. Because of the online surveys I enrolled in a computer class on my own" (Focus Group Interview, May 18, 2006).

- "As a new Charter School with [University], the University will assist in maintaining the technology infrastructure, purchasing new updated software and assisting [H6] to achieve the NASA goals."[2]
- H6 provided an Internet Web Design Workshop for students. "Students in the tech kids club will have the opportunity to work in an HTML-based program to create a personal website to be loaded to the Internet."[2]

The NES evaluation team also incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate more inclusive picture of how H6 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "20-40 times (weekly)" a year. Teachers also responded only "6-15 times" for using NASA materials in their classroom in a year.

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

H6 has received good feedback from parents and the community about the school efforts to improve students' achievement tests and the commitment made by the teachers.

Searching for postings about H6 outreach and family events on the web, we found the following comments about H6. The overall parent feeling positive and appreciate of the standards set for the H6 community.[3]

- ""This is a great school. I used to attend this school. When I graduated to middle school I was sad. The parent involvement is very high. The children are smart and well behaved. You feel like part of a huge family when you walk in. They are friendly and polite. They respect others and are very intelligent. The setting is great. Please send your child to this school. It is truly the best of the best. The teachers are kind and helpful. So is the staff and administration" (2006)
- I recently visited [H6] Elementary School and learned how this school is putting the mission of investing in our children into good practice and making an overwhelming difference in students' lives. Just five years ago, this school was the lowest performing school in the State of Maryland.

[3] The Great Schools website lists overall positive comments from parents of H6 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 17, 2007 from http://www.greatschools.net/).

Today, its fifth grade reading and math scores on the Maryland State Assessment Exam have reached 87 percent and 80 percent proficiency levels respectively. These scores exceed the state average. Now, [H6] Elementary School proudly takes its place as one of the top performing schools in Baltimore. During my visit to the school, I witnessed first-hand how the spirit of excellence is being instilled in the students. These young people are eager to learn and to grow. If you ask Principal Sandra Ashe how the school made such an amazing turnaround, she will credit her students' hard work and the commitment made by teachers, parents and the surrounding community to educating these students. "Neglect is the primary cause of a student's failure," she proclaimed. "If you don't water a plant, it will wither and die. The same principle holds true for nurturing the minds of our young people." [H6] has developed effective partnerships with the National Aeronautics and Space Administration (NASA) and with Southwest Airlines' Adopt-A-Pilot program to teach science, technology, and math in creative and challenging environments. [University] and the Baltimore Polytechnic Institute have also committed to provide mentorship programs and support services to help foster [H6]'s success (2006).[4]

- "Parent workshops are scheduled with NASA and with the wildlife department" (Focus Group Interview, May 18, 2006).
- "Parents helped with fundraising [to provide funds for activities and trips]" (Focus Group Interview, May 18, 2006).
- "We have increased partnerships and made them aware of NES (including [University], US Fish & Wildlife, Maryland … Foundation, Chesapeake Bay Foundation, Adopt a Pilot with Southwest Airlines). We get everyone involved in STEM-G activities. We include parents in every activity at [H6]" (Focus Group Interview, May 18, 2006).
- "Children have gone home and done experiments with their families. The parents come back and share with us that this has happened. Children help their parents use computers at activities. All of this gives us increased parent involvement and increased student interest. Field trips and classroom experiences help parents increase their knowledge and feel good about themselves (many of our parents are deficient)" (Focus Group Interview, May 18, 2006).

[4] Source retrieved May 21, 2007 from http://darkstarspoutsoff.typepad.com/my_weblog/black_self_help/index.html

- "Parent Involvement is a critical need for our school and parallels the goals for NASA Explorer School program. The school is located in a high crime with tremendous drug activity. There is a high rate of adult illiteracy. There is a high rate of one-parent or absentee parent households. Both factors contribute to the high rate of at risk students. Special programs for parents with an emphasis on skill development in reading, writing, math and technology have been planned. These programs will also utilize the rich content with NASA and U.S. Fish and Wildlife Services to develop the academic skills."[2]
- H6 scheduled a NASA Day focusing on careers. "This activity will introduce careers to the students, staff, and parents. Students were able to read and answer questions about several science related careers. This exposed many students to career possibilities they may not have considered previously."[2]

- H6 planned a Habitat Study and Design activity for December 2006, which had to be postponed until the 2007/2008 academic year (no reason given). "The families will study and create habitats including a lunar habitat."[2]

- H6 students attended an Earth Day event. "Students will attend an event put on the by the Baltimore City Department of Parks and Recreation that will allow them to learn about environmental awareness, participate in a park clean up, and play lawn games."[2] The e-Folio indicates that parents are expected to participate along with the students.

- H6 developed a STEM-G Game Night for students and their families with plans to do it in February 2007, but postponed it until later in the school year. "This is to get families to get a night where they learn games to apply their knowledge of STEM-G subjects."[2]

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

H6 incorporated NASA-sponsored activities to provide students with a variety of opportunities to become involved in hands-on STEM-G practice and discourse. 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 at H6 are given a variety of opportunities to be involved in clubs that relate to STEM-G learning areas. Two of the most popular clubs

are the environment and habitat club and the tech kids technology club. This activity is to build on the students and staffs interest and knowledge of STEM-G subjects in a non-traditional classroom setting."[2]

- H6 held a NASA Day with the focus on Astrobiology. "This activity will be the introduction to the study of astrobiology. It will be used to motivate the staff and students to begin to understand what is needed to sustain life. One of the NASA day activities was an hour long session about Astrobiology where students learned how scientists approach astrobiology as a discipline by utilizing hands on activities to teach observation, experimentation, etc."[2]
- H6 held a NASA Day with the focus on Robotics. "This day is used to introduce and motivate the staff and students to begin the study of robotics. Students were able to explore some of the challenges of commanding a robot from extreme distances. This allowed participating students to better understand some of the challenges faced by NASA engineers and explore creative solutions to directing robots."[2]
- H6 held a NASA Day with the focus on Rocketry. "This activity is an introduction to rocketry. It will be used as a motivator to increase participation of STEM-G activities. We had NASA engineers come into the gym and show students demonstrations related to rocketry. Students were able to make flight vehicles and measure the distances that the objects flew."[2]
- The H6 environment and habitat club chose to establish an ozone garden. "Students have begun to devise plans for the construction of an ozone garden on the school premises. Through the help of our habitat and environment club students are being exposed to ways of better caring for the environment and becoming more aware of nature."[2]
- H6 students attended an Earth Day event. "Students will attend an event put on the by the Baltimore City Department of Parks and Recreation that will allow them to learn about environmental awareness, participate in a park clean up, and play lawn games."[2] The e-Folio indicates that parents are expected to participate along with the students.

Changes in self-concept

- "We took the online survey to determine student interest; we identified science magazines to purchase through NSTA; we contacted TV stations about having students do the weather (we had one student do this already), two teachers attended an ozone monitoring workshop" (Focus Group Interview, May 18, 2006).

Attitude changes about learning

- "There is a new sparkle in the children's eyes. We are using art and music along with math and science to help them accomplish goals and feel good about themselves. Activities have been provided that are sixth grade level even for kids performing at a lower grade level. There is a new sparkle in the children's eyes. We are using art and music along with math and science to help them accomplish goals and feel good about themselves. Activities have been provided that are sixth grade level even for kids performing at a lower grade level" (Focus Group Interview, May 18, 2006).
- "Children have gone home and done experiments with their families. The parents come back and share with us that this has happened. Children help their parents use computers at activities. All of this gives us increased parent involvement and increased student interest. Field trips and classroom experiences help parents increase their knowledge and feel good about themselves (many of our parents are deficient)" (Focus Group Interview, May 18, 2006).
- The 2007 All Star Schools report (Hull, 2007) indicates that [H6] had mean scores at least one standard deviation above the overall item mean scores on the items listed below. School means and grades are in parentheses beside the school names, and the "top 3" for each item are underlined.
    - "Tell us how much you like …Math" (3.92, 4-6) [H6]
    - "How much would you like to have these jobs…Computer Specialist" (3.41, 4-6) [H6]
    - "How often do you or your teachers use NASA materials in…Geography" (2.72, 4-6) [H6]

Attendance in classes

- "This is valuable to me so I support the activities. Anything that will make a difference in the success of the children is important to me. Teamwork, completing projects, new experiences where the children come back so excited and what they have done and consequently they are excited about school. This gives us increased attendance and increased interest. It helps us meet AYP (adequate yearly progress)" (Focus Group Interview, May 18, 2006).

Actively participation in hands-on and authentic scientific research

- "We took the online survey to determine student interest; we identified science magazines to purchase through NSTA; we contacted TV stations about having students do the weather (we had one student do this

already), two teachers attended an ozone monitoring workshop" (Focus Group Interview, May 18, 2006).

Outcome 5. Increased student knowledge about careers in STEM-G.

H6 School teachers have observed student changes in self-identity when they are exposed to different career choices that they had not yet considered before. A field trip to their local field center helped students understand the responsibility of different career choices and allowed them to ask questions and receive responses from real scientists.

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

- "We did a NASA-sponsored activity, a trip to the Air and Space Museum. The children got to go on a simulated aircraft (some staff members got brave and tried too!). We saw robots (that talked to the children and answered questions about space). We saw exhibits, heard music, took pictures. We saw Imax movies that made me feel as if we took off in a space ship to Mars. The food was delicious. The meal was elegant-served on china and using real glasses to drink from" (Focus Group Interview, May 18, 2006).

- H6 scheduled a NASA Day focusing on careers. "This activity will introduce careers to the students, staff, and parents. Students were able to read and answer questions about several science related careers. This exposed many students to career possibilities they may not have considered previously."[2]

Increase understanding and enthusiasm about STEM-G careers

- "We had our kickoff in October with NASA people (an engineer and NASA officials attended); we showed a film on what it is to be an astronaut; we did robotics and aeronautics activities for student with our AES; we integrate our NASA materials with art, music and special activities; we entered the music competition; we display student art throughout the building. For careers we made a DVD, attended two IMAX movies; we go online; our students are mentored by several organizations (Black Engineers Conference, *Alpha Psi Alpha* for girls; *Alpha Ki Alpha* for

boys, Coppin State University mentors our talented students)" (Focus Group Interview, May 18, 2006).

- "The interest level of children has skyrocketed. They talk about how they could be an astronaut or part of the NASA program" (Focus Group Interview, May 18, 2006).
- H6 held a NASA Day with the focus on Robotics. "This day is used to introduce and motivate the staff and students to begin the study of robotics. Students were able to explore some of the challenges of commanding a robot from extreme distances. This allowed participating students to better understand some of the challenges faced by NASA engineers and explore creative solutions to directing robots."[2]
- H6 held a NASA Day with the focus on Rocketry. "This activity is an introduction to rocketry. It will be used as a motivator to increase participation of STEM-G activities. We had NASA engineers come into the gym and show students demonstrations related to rocketry. Students were able to make flight vehicles and measure the distances that the objects flew."[2]

Share information with their peers and parents

- "We have students report to other students about their experiences at assemblies and in morning announcements" (Focus Group Interview, May 18, 2006).
- "Children have gone home and done experiments with their families. The parents come back and share with us that this has happened. Children help their parents use computers at activities. All of this gives us increased parent involvement and increased student interest. Field trips and classroom experiences help parents increase their knowledge and feel good about themselves (many of our parents are deficient)" (Focus Group Interview, May 18, 2006).
- H6 planned a Career Day for students and parents in May 2007, but had to postpone it until spring 2008. "This day will be a day when people employed in a STEM-G career will share their experiences with the students and their parents."[2]

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

H6 teachers have observed significant change in students' achievement. The school has also met AYP for the past three years. Reading and math scores are

above state averages, and expectations for H6 have increased since they have developed a partnership with NES.

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

- H6 held a NASA Day with the focus on Robotics. "This day is used to introduce and motivate the staff and students to begin the study of robotics. Students were able to explore some of the challenges of commanding a robot from extreme distances. This allowed participating students to better understand some of the challenges faced by NASA engineers and explore creative solutions to directing robots."[2]
- H6 held a NASA Day with the focus on rocketry. "This activity is an introduction to rocketry. It will be used as a motivator to increase participation of STEM-G activities. We had NASA engineers come into the gym and show students demonstrations related to rocketry. Students were able to make flight vehicles and measure the distances that the objects flew."[2]
- The H6 environment and habitat club chose to establish an ozone garden. "Students have begun to devise plans for the construction of an ozone garden on the school premises. Through the help of our habitat and environment club students are being exposed to ways of better caring for the environment and becoming more aware of nature."[2]
- H6 students participated in a schoolwide Science Fair. "Students will be conducting scientific experiments to test their various hypotheses on a range of scientific topics."[2]

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

- H6 has planned an in-house robotics competition for the 2007-2008 academic year to "prepare the students for external competitions."[2]
- H6 provided an Internet Web Design Workshop for students. "Students in the tech kids club will have the opportunity to work in an HTML-based program to create a personal website to be loaded to the Internet."[2]

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

Teachers describe the gains that H6 has made over the past few years—especially being removed from the NCLB reconstitution list and exceeding state averages in third and fourth grade math achievement scores.

- "…. Gives us increased attendance and increased interest. It helps us meet AYP (adequate yearly progress)" (Focus Group Interview, May 18, 2006).
- "We have started to score ABOVE the state levels in reading and math. Expectations are high because people know we are [H6] and that we are a NASA Explorer school" (Focus Group Interview, May 18, 2006).
- H6 became a Charter School with [University] (CSU) as the operator in August 2006. As a result of this new initiative, [H6] was removed from the state's reconstitution-eligible list, due to the gains made on the present State's standards."[1]
- "Four years ago, [H6] was the second lowest scoring school in the State of Maryland. At the end of the 2001-2002 school year, [H6] was recognized for making the greatest amount of improvement in the city. At the end of the 2002-2003 school year, [H6] was awarded nearly $4,000 for successfully making Adequate Yearly Progress and being removed from the reconstitution list. For several years, [H6] has been scoring higher than Baltimore City in most areas of the state test and exceeding the state standard in third, fourth, and sixth grade math, also in sixth grade reading/language arts."[2]

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population	300*	327*		410**
Black, non-Hispanic	298*	325*		410**
Asian	0*	1*		0**
Hispanic	0*	0*		0**
Indian, Alaskan Native	0*	0*		0**
White, non-Hispanic	2*	1*		0**
School location (rural, suburban, urban, mid-size central city)	Large City*	Large City*		Urban**
School type (public, private, charter, magnet)	Public*	Public*		Charter**
Title 1 status (yes or no)	Yes*	Yes*		Yes**
Free and reduced price lunch	283*	286*		89.6%**

*National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 17, 2007 from http://nces.ed.gov/ccd/bat/

** e-Folio. (2007). NASA Explorer Schools. Retrieved May 18, 2007 from http://explorerschools.nasa.gov/portal/site/nes/menuitem.d601ef1f9fdc2c2d7010ea1051008a0c/

Table 2. Summary of Academic Needs Identified by H6 in 2003

Priority	Discipline	Category	National Standard
1	Principles and Standards for School Mathematics	Problem Solving	Apply and adapt a variety of appropriate strategies to solve problems
2	Standards for Technological Literacy	Design	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
3	National Educational Technology Standards		Design, develop, publish, and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom.
4	Standards for Technological Literacy	The Nature of Technology	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study
5	Principles and Standards for School Mathematics	Representation	Use representations to model and interpret physical, social, and mathematical phenomena
6	National Science Education Standards	Life Science	Populations and ecosystems
7	Principles and Standards for School Mathematics	Communication	Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
8	National Geography Standards	The world in spatial terms	How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
9	National Geography Standards	Environment and society	The changes that occur in the meaning, use, distribution, and importance of resources
10	National Geography Standards	Human systems	The process, patterns, and functions of human settlement.

Source: H6 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that H6 Teachers Completed

Ozone Monitoring Workshop
2006 Student Symposium
Joint staff development activity with Goddard Space Flight Center (GSFC) and the Patuxant Wildlife Visitor Center
H6 teachers co-taught with NASA educators at an activity day
Exposure to GIS through the agricultural department
LandSat activity for teachers
2006 NASA Astrobiology Workshop (ARC, San Jose, CA)
2006 National Council for Geographic Education (NCGE) Annual Meeting
2006 Staff Retreat at the National Conservation Training Center
2006 National Middle School Association (NMSA) Annual Conference (Nashville, TN)
2006 National Science Teachers Association (NSTA) Area Conference (Salt Lake City, UT)
International Technology Education Association (ITEA) Annual Conference (San Antonio, TX)

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That H6 Teachers Incorporated into Their Instruction

NASA Funding
NASA Regional Center and Staff
NASA activities, posters, lesson plans, workshop materials, and websites
GEMS guides (Oobleck)
NASA lesson plans, workshop materials
Effector Creation Materials
Robotics

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. H6 MSA Grade 3 Scores

	Reading	Math
2003	29%	45%
2004	58%	73%
2005	68%	72%
2006	54%	82%
State Average in 2006	78%	79%

Source: MSA Results. (2005-2006). Maryland Dept. of Education. Downloaded 05-02-2007 from http://www.marylandpublicschools.org/msde

Table 6. H6 MSA Grade 4 Scores

	Reading	Math
2003		
2004	64%	66%
2005	66%	68%
2006	80%	84%
State Average in 2006	82%	82%

Source: MSA Results. (2005-2006). Maryland Dept. of Education. Downloaded 05-02-2007 from http://www.marylandpublicschools.org/msde

Table 7. H6 MSA Grade 5 Scores

	Reading	Math
2003	41%	53%
2004	63%	80%
2005	87%	80%
2006	66%	57%
State Average in 2006	77%	73%

Source: MSA Results. (2005-2006). Maryland Dept. of Education. Downloaded 05-02-2007 from http://www.marylandpublicschools.org/msde

NASA Explorer Schools Case Study Profile: I38
2005 Cohort — Rural, Tennessee Public Elementary School: PreK-8

Summary Comments Regarding I38
I38 is a rural, public elementary school serving grades Pre-K through 8th grade in the foothills of the Great Smoky Mountains. I38 is a schoolwide Title I institution. The school population is around 204. A breakdown of the student population by race/ethnicity is not currently available (See Table 1).

Here are some of the successes that I38 achieved during its three-year period as a NASA Explorer School:

- I38 established a NASA-rich environment by immersion in space themes throughout the school through the addition of a large space mural, NASA-themed bulletin boards, and NASA STEM-G activities.
- I38 purchased technology tools, I38 teachers received professional development on how to use the technology, and I38 students in turn benefited either from classroom use or hands-on use of the technology purchased by I38.
- NASA materials and especially use of the Digital Learning Network (DLN) were integrated into I38 classrooms.

As a school that serves a predominantly poor population, I38 must overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- Late funding was an issue because it delayed the purchase of videoconferencing equipment and use of DLN programs which are important because of I38's rural location.
- I38 experienced technology problems with the firewall in their computer system.
- I38 is a rural school and does not have a partner in education.
- The I38 NES team initially encountered jealousy from non-team teachers, but they have since alleviated it by sharing professional development opportunities and including non-team teachers in NES schoolwide activities.
- The E38 NES team encountered a lack of support from their district central office.

We examined schoolwide achievements at I38 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 transcript of a focus group interview conducted by telephone with the I38 NES team on April 25, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES I38 team was formed in 2005 and consists of the team lead who teaches 6th, 7th, and 7th grade science; a school administrator, a 2nd grade teacher, a 6th, 7th, and 8th grade English teacher who also serves as the technology person, and an Intermediate teacher. One of the initial team members left because of school funding issues and cutbacks, but she was replaced with another teacher. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation I38 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, NASA-nauts, Math Night, "Say Cheese! Digital Moon Phases," Group Geocaching, NASA Family Night, International Toys in Space, "What's Hot? What's Not?," multiple DLN Events, "How High Is It? The Five Layers of the Earth's Atmosphere," Planet Hopping: Exploring the Solar System with Math," Career Fair, GEMS Workshop, Robotics, and "Say Cheese! Digital Leaf Collection." Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that I38 has taken advantage of as a NASA Explorer School.

NES team members feel that they benefited from the professional development opportunities provided by the NASA Explorers School program. The NES team made a special effort to share NES opportunities schoolwide and even opened on-site training to other teachers in their county. They have brought knowledge, materials, and new instructional strategies from workshops and conferences directly into their classrooms as well as sharing with their colleagues. They have made good use of the Digital Learning Network (DLN) and have even partnered with a sister NES school for a DLN event. The I38 team keeps the school needs (see Table 2) in mind as they plan activities and select which workshops to attend.

The next section examined the extent to which the I38 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.

- "I attended 10 workshops, a 4 ½ hour "Fragile Ice Symposium," and a field trip to Antelope Island in the southern section of the Great Lake in order to increase cross-curricular instruction in the math and science classes in our school. Workshop content ranged from NASA sponsored workshops on Mercury and Black Holes, to digital learning networks, to

engineering resources, to population ecology, to practical weather data collection. All the workshops and activities have given ideas which will help increase student interest, knowledge, and abilities to use this information, as well as increase the students' abilities to incorporate the use of technology."[2]

- An I38 teacher attended the National Science Teachers Conference (NSTA) and reported, "I gained knowledge about teaching inquiry lessons in science. I also collected resources to share with colleagues."[2]

In addition to our analyses from case study, we report some key findings from the survey data on I38. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often do students in this class take part in doing hands-on/laboratory activities, three teachers responded "1-3 times per month," and one responded "1-3 times per week" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often do students in this class take part in working in small groups to come up with joint solutions or approach to a problem or task, three out of four teachers responded "1-3 times per week," and one responded "1-3 times per month" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often the teachers accomplish the following goals:
    - Elicit students' ideas and opinions: Two teachers responded "always" while two responded "very often."
    - Get students to justify and explain their reasoning: Three out of four teachers responded "always," and one said "very often. "
    - Have students relate what they are working on to their own experience: Three out of four teachers responded "always," and one said "very often. "
- When asked in the Teacher Involvement survey how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, all four teachers responded "some."

Guideline 2. Time Intensive.

- "The coordinator at [Field Center I] has been very helpful with implementation and in allowing the AES person to come to the school six times this year" (Focus Group Interview, April 25, 2006).
- In response to being asked how NES has helped teachers at I38, one teacher responded, "We got trips, professional development, we helped

[2] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007, from http://aesp.nasa.okstate.edu/efolio

faculty learn new things about science" (Focus Group Interview, April 25, 2006).

- One I38 teacher attended the International Conference for Technology and Engineering in San Antonio, TX. She participated with the intent to "assist [I38] in better preparing our students for decision making and skills to be used in the real world and to help meet our STEM-G requirements. There will be many presenters and educational resources to help incorporate these into our elementary classroom."[2]
-
- Four I38 teachers participated in a DLN event which covered the topic of "Living and Working in Space" and "Using NASA Resources in the Classroom."[2]

Guideline 3. Classroom Practices.

- "It's easier to give the materials to teacher but not as easy to get them to tell you how they implemented it" (Focus Group Interview, April 25, 2006).
- Four I38 teachers participated in a DLN event that covered the topic of "Living and Working in Space" and "Using NASA Resources in the Classroom."[2]

Guideline 4. Content Knowledge.

- In response to being asked how NES has helped teachers at I38, one teacher responded, "We got trips, professional development, we helped faculty learn new things about science" (Focus Group Interview, April 25, 2006).
- GEMS presented a DLN workshop at I38 for 32 educators from across the county. The GEMS guide and color analyzers were presented to participants."[2]

Guideline 5. Active Learning.

We pulled information from the I38 posting on the NASA Digital Portfolios website to gather information regarding how this team planned to connect their NES activities with specific standards for student performance. Here several teacher quotes that describe the I38 team's approach to integrating NES activities with their school academic goals:

- "Based on our test data from the Tennessee Comprehensive Assessment Program (TCAP) we feel that we can focus on the five goals of the NES program as we meet our School Improvement Plan goals to improve our achievement in math, language arts, science, and social studies."[2]

- "We plan to involve the whole school community as we focus upon class and student projects, schoolwide events, and the development of available resources."[2]

A review of the I 38 website suggests that the team is successfully implementing their plan as five different DLN events are posted on the school's NES digital portfolio pages. In one of the start-up events using DLN the NASA education specialist incorporate discussions about the videoconferencing technology while addressing topics that meet the kindergarten standards. Here is how I38 describes this activity:

- "This activity is a way to introduce my kindergarten students to our DLN equipment. Understanding how our DLN system works is a very abstract concept. Because of this, the NASA education specialists have designed several 30-minute sessions of DLN activities. During these activities, they will read a variety of stories to the students. These stories will focus on the science standards for kindergarten. While reading they will ask questions and encourage discussion of concepts. ."[2]
    - Reflection by teachers after the event: During this activity, the kindergarten students became familiar in the use of our DLN equipment. They were rather hesitant to talk or answer questions during the first lesson. However, after completing more DLN lessons, the students became more comfortable. The NASA specialists provided my class with lessons that focused on kindergarten standards. The students learned about eating and living in space. They also completed an inquiry lesson in which they were to predict how various toys would work in space."[2]

Guideline 6. Coherence.

The I38 team began their participation in NES with a vision to help students increase their learning in STEM-G areas in an environment that is student-centered and inquiry-driven. They plan to involve the whole school in class and individual student projects and schoolwide events. Below are excerpts from their three-year objectives for their involvement in NES:

- The first year strategic plan focuses on exploration goals that include: establishing a NASA rich environment with access to technology, an introduction to careers in STEM-G areas, introduction to real-life problem-solving with the inquiry method, development of activities and resources, provisions for professional development, and initiation of consistent family and community opportunities that foster awareness of STEM-G.
- The second year of our strategic plan focuses on discovery goals that include the following: immersing students in a STEM-G climate using NASA programs and resources, expanding technology, implementing a STEM-G career symposium, and empowering learning through problem

based activities, projects, presentations. We also plan to broaden use of NASA, business, and community resources, establish a plan of action for professional development for all teachers and disciplines, and encourage family participation through regularly scheduled programs and activities.

- In the third year of the strategic plan we will… facilitate active participation, engage students extensively in the use of Distance Learning Network (DLN), further career exploration with field trips, shadowing, and DLN concepts. In addition, we will develop student-led inquiry learning with activities and projects, sustain and further expand our NASA, business, and community partnerships, broaden opportunities to nurture professional development among staff members, and further expand family involvement through the use of school-to-home activities for students and their parents.

The I38 team has also taken advantage of the NES support for professional development conferences to find ways to get skill-development they need through educator professional societies. Here is one example:

- One I38 teacher attended the International Conference for Technology and Engineering in San Antonio, TX. She participated with the intent to "assist [I38] in better preparing our students for decision making and skills to be used in the real world and to help meet our STEM-G requirements. There will be many presenters and educational resources to help incorporate these into our elementary classroom."[2]

Summary of How I38 Meets Outcome 1.
I38 NES teachers have found the professional development workshops are helpful in learning how to teach inquiry-based science lessons. Information is brought back to the school to share with other teachers. The NES team strives to meet school goals as well as NES goals. Attending various conferences has better equipped teachers to teach more effectively and efficiently.

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

The I38 team purchased the following technologies with NES funding:

- Tandberg DLN
- Tandberg Natural Presenter Package
- Samson Handheld Microphone
- Samson Wireless LAV
- Microphone Clips & Stands
- Yamaha Sound System & Speaker Stand with adapter
- Digital Camera (Bought one in 2005 and a second in 2006)
- Digital Camcorder

- GPS Unit
- Toshiba Laptop
- Lego Robotics Team Challenge Kit

I38 aligned their technology purchases with activities they planned to implement in the classrooms. Teachers received training on the technology and integrated it into lessons so that students would not only be exposed to new technology, but also have hands-on experience using it. In addition to the schoolwide use of DLN, technology has been incorporated into classrooms through:

- GEMS presented a DLN workshop at I38 for 32 educators from across the county. The GEMS guide and color analyzers were presented to participants."[2]
- Robotics was introduced during I38's Family Night. "During a family night, 6th, 7th, and 8th grade students, along with their parents, will use LEGO Robotics kits to design and program a robot to complete specific tasks. These tasks could include maneuvering through a maze."[2]
- I38's "Say Cheese! Digital Leave Collection" activity integrated technology into a science lesson. "Students take photos of 10 different leaves (and the bark to identify). Students provide the common name, scientific name, leaf description, and a description of the habitat of the tree. Students choose a presentation type and present findings to classmates orally."[2]

We incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate a more inclusive picture of how I38 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "20-40 times (weekly)" a year. Teachers also responded only "6-15 times" for using NASA materials in their classroom in a year.

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

Searching for postings about I38 outreach and family events on the web, we found the following comment from a parent of an I38 student. The overall parent feeling positive and appreciate of the standards set for the I38 community.[2]

> "My child is a second grader at I38. The teacher is great and the school is great. I would not want to send her anywhere else. I have a choice where I

[2] The Great Schools website lists overall positive comments from parents of I38 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 4, 2007 from http://www.greatschools.net/).

> live for her to go to Pittman center, Catons Chapel or Pigeon Forge. I chose E38 for a lot of reasons. I feel E38 does not always get the recognition it deserves for the good education it gives. I feel the students at E38 could compete with any of the bigger schools in schools their education because being a smaller school there is more one on one time for student, also we can't forget the family atmosphere there. Keep up the great work!" (December 2004).

I38 listed one of their goals as increasing family involvement and appear to have enjoyed success in this endeavor. Their plans to engage families included fun things like family pictures, as well as activities which increased family content knowledge and gave families opportunities to participate in hands-on activities with their children.

- "A photographer was able to do family pictures—8 x 10's on family kick-off night and we would not have been able to do this [without the help of the NES coordinator]" (Focus Group Interview, April 25, 2006).
- "On family night we had 150 people in the school. It has been really good for the community" (Focus Group Interview, April 25, 2006).
- NASA Family Night included sessions presented by an Aerospace Education Specialist and Jennifer Kirkmeyer from the University of Tennessee's Archaeological Research Lab. Families then participated in a special Family Challenge where they were asked to construct a roller coaster from provided materials."[2]
- Robotics was introduced during I38's Family Night. "During a family night, 6th, 7th, and 8th grade students, along with their parents, will use LEGO Robotics kits to design and program a robot to complete specific tasks. These tasks could include maneuvering through a maze."[2]

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

I38 students were provided with many opportunities to participate in STEM-G activities. In addition to classroom visits by AES staff, they also participated in many DLN events. Teachers feel that the students are learning more and asking more questions.

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

- Eight one-hour classroom visits by the Aerospace Education Specialist included story telling There's No Place Like Space! And presentations on topics such as "Why is Water Sticky?," ratios and scale modeling, and observing sunspots."[2]
- The DLN event "Fly Us to the Moon: Why Go There" introduced students to what has been learned from NASA's lunar science programs and why the Moon will be an important outpost for human exploration of the solar system."[2]
- The DLN event "Planet Hopping: Exploring the Solar System with Math" introduced students to different ways of looking at the planets in our solar system. Methods used include astronomical modeling of orbits and sizes, geologic modeling of planetary interiors, and biological evaluation of what makes planets habitable by various forms of life."[2]
- The DLN event "Simple Machines: introduced students to the idea that "a complex machine, like an airplane, is really nothing more than a collection of simple machines. To design and build better airplanes, students must develop an understanding of the mechanics of simple machines. Students will demonstrate an understanding of simple machines and their use on aircraft and identify the simple machines that are used complex machines."[2]

Noticeable curiosity in STEM-G topics and events

- When asked about the impact of the NES program on their students, one teacher responded, "The students now learn more, they ask questions, and there's more excitement for what they learn" (Focus Group Interview, April 25, 2006).

Changes in self-concept

- When asked about the impact of the NES program on their students, one teacher responded, "We could go on and on about this all day. It had opened doors for them. The AES person and the astronaut came out to the students. The students realize now that they are people just like them" (Focus Group Interview, April 25, 2006).

Outcome 5. Increased student knowledge about careers in STEM-G.

The interaction of I38 students with NASA professionals and professionals from their region who work in STEM-G fields has helped the students understand that if they pursue the right training and education, they too can have a STEM-G

career. I38 students were able to discuss and share what they learned about STEM-G careers with their peers. They also had opportunities to share information with their peers when presenting their data from the "Say Cheese! Digital Leave Collection" activity.

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

Increase understanding of the enthusiastic about STEM-G careers

- Fifth through eighth grade students were given an opportunity to discuss STEM-G careers in class. The students then participated in a DLN event addressing STEM-G career opportunities. A variety of NASA professionals was interviewed. I38 partnered on this event with a sister-NES school from their region."[2]
- I38 invited area business partners to a Career Fair to present hands-on activities and information regarding the qualifications, background, and education needed to pursue a career in their field."[2]

Share information with their peers and parents

- Fifth through eighth grade students were given an opportunity to discuss STEM-G careers in class. The students then participated in a DLN event addressing STEM-G career opportunities. A variety of NASA professionals was interviewed. I38 partnered on this event with sister-NES school from their region."[2]
- I38's "Say Cheese! Digital Leave Collection" activity integrated technology into a science lesson. "Students take photos of 10 different leaves (and the bark to identify). Students provide the common name, scientific name, leaf description, and a description of the habitat of the tree. Students choose a presentation type and present findings to classmates orally."[2]

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

I38 students participated in activities through the NES program in which they learned concepts and were asked to use them to explain or predict things in the context of a problem-solving activity ("Say Cheese! Digital Moon Phases," Family Roller Coaster Challenge, International Toys in Space, Earth and Space Science, Motions and Forces). Many of the activities incorporate technology such as GPS units, digital cameras, DLN, or robotics.

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

- Eighth grade math and science students participated in the "Say Cheese! Digital Moon Phases" activity. Working with partners, students formulated questions about the phases of the moon and recorded their questions in journals, held daily 15-minute discussions, used a digital camera to photograph the moon phases and displayed the data on a calendar. They did a follow up activity to predict three days of moon phases and to determine what phase the moon was in on their birthday."[2]
- NASA Family Night included sessions presented by an Aerospace Education Specialist and [Scientist] from the University of Tennessee's Archaeological Research Lab. Families then participated in a special Family Challenge where they were asked to construct a roller coaster from provided materials."[2]
- Eighth grade students participated in the International Toys in Space activity. They completed a two-day investigation on the physics behind how four toys work on Earth (jump rope, soccer ball, paper boomerang, and kedama). They described how the toys work on Earth and then predicted how they might work in the microgravity environment of the International Space Station."[2]
- Students participated in a two hour session on Earth and Space Science/Earth in the Solar System. They were asked to make a model of Earth's atmospheric layers and graph where aircraft, satellites, and spacecraft operate. Students then interpreted the graphs and were asked to draw conclusions about why objects operate in specific atmospheric layers."[2]
- I38's eighth grade science class participated in an activity on motions and forces, which occurred over two sessions. In the first session, students conducted an experiment to measure the relationship between the surface area of a tablet and its reaction rate in water. In the second experiment, students measured the reaction rate of tablets in water of varying temperatures."[2]

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

- Eighth grade math and science students participated in the "Say Cheese! Digital Moon Phases" activity. Working with partners, students formulated questions about the phases of the moon and recorded their questions in journals, held daily 15-minute discussions, used a digital

camera to photograph the moon phases and displayed the data on a calendar."[2]

- Seventh grade geography and reading classes read the book My Brother Sam is Dead. They explored and discussed the events in the book and did a geocaching activity to answer questions about the book. Students had to use longitude and latitude to find the questions and clues."[2]
- A series of four thirty-minute special DLN events were held for I38's kindergarten class to introduce them to the use of DLN while introducing science concepts. Stories were read to the students (including The Air We Breathe) and they were encouraged to ask questions and participate in discussion with the DLN presenters."[2]
- Robotics was introduced during I38's Family Night. "During a family night, 6th, 7th, and 8th grade students, along with their parents, will use LEGO Robotics kits to design and program a robot to complete specific tasks. These tasks could include maneuvering through a maze."[2]
- I38's "Say Cheese! Digital Leave Collection" activity integrated technology into a science lesson. "Students take photos of 10 different leaves (and the bark to identify). Students provide the common name, scientific name, leaf description, and a description of the habitat of the tree. Students choose a presentation type and present findings to classmates orally."[2]

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

- I38 TCAP test scores show a large disparity between female and male students at the 6th grade level. Female students are outperforming male students by 60% in the area of reading/language arts and by 20% in the area of math. Test scores appear to even out when students reach 8th grade. See Tables 11 and 12 for details.
- I38 School has met AYP in the years of 2004-2005 and 2005-2006.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population				
Black, non-Hispanic				
Asian				
Hispanic				
Indian, Alaskan Native				
White, non-Hispanic				
School location (rural, suburban, urban, mid-size central city)		Rural, outside CBSA/MSA	Rural, outside CBSA/MSA	
School type (public, private, charter, magnet)		Public	Public	
Title 1 status (yes or no)		Yes	Yes	
Free and reduced price lunch				

Note: E38 did not report race/ethnicity or Free and reduced price lunch data.

Source: National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 2, 2007 from http://nces.ed.gov/ccd/bat/

Table 2. Summary of Academic Needs Identified by I38 in 2005

Priority	Discipline	Category	National Standard
1	National Educational Technology Standards		Use content-specific tools, software, and simulations to support learning and research.
2	National Educational Technology Standards		Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
3	Principles and Standards for School Mathematics	Measurement	Understand measurable attributes of objects and the units, systems, and processes of measurement
4	Principles and Standards for School Mathematics	Measurement	Apply appropriate techniques, tools, and formulas to determine measurements
5	Principles and Standards for School Mathematics	Data Analysis and Probability	Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
6	National Geography Standards	The world in spatial terms	How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
7	Principles and Standards for School Mathematics	Problem Solving	Apply and adapt a variety of appropriate strategies to solve problems
8	National Science Education Standards	Earth and Space Science	Earth in the solar system
9	National Science Education Standards	Physical Science	Motions and Forces
10	Principles and Standards for School Mathematics	Problem Solving	Solve problems that arise in mathematics and in other contexts

Source: I38 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that I38 Teachers Completed

Montana Trip
National Science Teachers Association (NSTA) Conference (Salt Lake City, UT)
Math Conference
Fragile Ice Symposium (at NSTA)
Freezing on Mercury Workshop (at NSTA)
Exploring Black Holes Workshop (at NSTA)
Content Workshop-Astrobiology
Content Workshop-Robotics

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That I38 Teachers Incorporated into Their Instruction

NASA personnel (AES, astronauts, speakers, partners)
NSTA Science and Children Magazine
NASA website
Digital Learning Network (DLN)
The Air We Breathe
How High Is It? An Educator's Guide with Activities Focused on Scale Models of Distances
GEMS from the Astrobiology Workshop
NES Update
STS-118 Design Challenge
Rockets-Educator's Guide
Resources from attending the National Conference
JPL Robotics with LEGO Robotics Kits
International Conference for Technology and Engineering (ITEA), San Antonio, TX

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. I38 TCAP Grade 3 Scores

	Reading/Language Arts	Math
2003	NA	NA
2004	NA	NA
2005	88%	79%
2006	100%	100%
State Average in 2006	89%	88%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 6. I38 TCAP Grade 4 Scores

	Reading/Language Arts	Math
2003	NA	NA
2004	NA	NA
2005	78%	89%
2006	96%	100%
State Average in 2006	88%	88%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 7. I38 TCAP Grade 5 Scores

	Reading/Language Arts	Math
2003	NA	NA
2004	NA	NA
2005	100%	94%
2006	86%	88%
State Average in 2006	92%	92%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 8. I38 TCAP Grade 6 Scores

	Reading/Language Arts	Math
2003	NA	NA
2004	NA	NA
2005	87%	96%
2006	77%	92%
State Average in 2006	88%	88%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 9. I38 TCAP Grade 7 Scores

	Reading/Language Arts	Math
2003	NA	NA
2004	NA	NA
2005	84%	89%
2006	92%	82%
State Average in 2006	87%	88%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 10. I38 TCAP Grade 8 Scores

	Reading/Language Arts	Math
2003	NA	NA
2004	NA	NA
2005	95%	81%
2006	90%	83%
State Average in 2006	90%	85%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 11. I38 2005-2006 TCAP Reading/Language Arts Scores By Gender

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Female	100%	100%	97%	100%	93%	94%
Male	100%	91%	75%	40%	90%	87%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

Table 12. I38 2005-2006 TCAP Math Scores By Gender

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Female	100%	100%	89%	100%	93%	83%
Male	100%	100%	88%	80%	70%	82%

Source: TCAP Results. (2005-2006). Tennessee Dept. of Education. Downloaded 05-04-2007 from http://www.state.tn.us/education/

NASA Explorer Schools Case Study Profile: J22
2005 Cohort—Urban, Virginia, Public Elementary School: Grades PK-5

Summary Comments Regarding J22
J22 is an urban public elementary school located in Virginia serving grades PK-5. This school was first established in 1939; the current building was recently renovated and expanded to serve the rapidly growing population in northern Virginia. There are currently 740 Pre-Kindergarten through fifth grade students currently attending J22 and participating in the NASA Explorer Schools program. J22 is a Title 1 school, and the student population is almost 45 percent minority. Thirty percent of student population is eligible to receive free or reduced lunch. See Table 1 for additional demographic information.

Here are some of the successes that J22 achieved during its three-year period as a NASA Explorer School:

- According to the school report card, J22 did not make AYP in 2004-2005, but did make AYP in the last two academic years, 2005-2006 and 2006-2007. In looking at the test scores in math and English, there is an identifiable gap between the test scores of J22 White and Black students in both subjects. English test scores show that the gap has diminished from 14% in 2004-2005 to 6% in 2005-2006. The gap in math scores has also shown improvement, moving from 23% in 2004-2005 to 8% in 2005-2006.
- J22 has established a partnership with Lockheed Martin.
- DLN was integrated into the J22 curriculum to spark student interest and put them in touch with NASA staff and exciting technology.
- J22 integrated NASA information across their curriculum, creating NASA Tiger TV, a combination of communication arts and NASA content.
- The Jason Project: Mysteries of Earth and Mars supports the effort of J22 teachers to increase the ability of students to apply science, mathematics, and technology.
- J22 School has successfully documented their NES implementation and is considered a model school for best NES e-Folio.

J22 had to overcome challenges that compete with STEM-G-related reform activities for teacher and administrator attention. Here are some of these challenges:

- Late funding was a challenge for J22. "Our major challenge was the money not arriving. We were going to take pictures of activities and we had to share a camera. Then, in good faith, the district bought the videoconferencing equipment and we had no idea of when the $10,000 was coming. We are a little wary of next year. We have plans for robotics for next year and we do not want to say much to the kids or the parents

about it because we may not be able to do it" (Focus Group Interview, May 18, 2006).
- The J22 team found documenting their activities was time consuming. They were worried that using e-Folio would also be time consuming.
- J22 has a lot of newcomers who speak Spanish as their primary language.

We examined schoolwide achievements at J22 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 transcript of a focus group interview conducted by telephone with the J22 NES team on May 31, 2006. We have also used school website, survey data, and U.S. Department of Education school data to expand upon information provided in the interviews.

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

The NES J22 team was formed in 2005 with five members: the school administrator is the current school principal; the team lead and three other team members are classroom teachers. Table 2 provides a list of the academic needs the startup team identified when first joining the NES project. During its NES participation J22 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 DLN events, Walk on the Moon IMAX movie premiere, Jason Project, Space Day, Student Symposium, attended the Zathura movie, and the Reduced Gravity Jet. Tables 3 and 4 provide a summary of the professional development opportunities and NASA resources that J22 has taken advantage of as a NASA Explorer School.

The next section examined the extent to which the J22 school implementation of NES addresses the six guidelines for professional growth and development described below.

Guideline 1. Instructional Strategies.
- "This is the fourth year with the Jason Project and it was a perfect tie-in" (Focus Group Interview, May 18, 2006).
- "Students wrote and produced television programs for the J22 school audience on a variety of NES events. Students participated in the NES Lights, Camera, and Action competition. The video communication arts

teacher provided many opportunities for students to create projects with the NASA theme."[1]

- As documented in the e-folio, a NES J22 teacher talked about an activity that students were working in their groups to measure their length of flight line in the groups, put the balloons in the bag, let it go, and see how the air pressure affected the balloon rockets. Students also wrote something about this activity and what they learned from it."[1]

In addition to our analyses from the case study, we report some key findings from the survey data on J22. These data shed new light on the results of case study analyses and serve as data triangulation with our case study findings.

- When asked how often students in this class take part in hands-on/ laboratory activities, one teacher responded "1-3 times per week," and two responded "almost everyday" in the Teaching, Learning, and Computing (TLC) survey.
- When asked how often students in this class take part in working in small groups to come up with joint solutions or an approach to a problem or task, one teacher responded "sometimes," one responded "1-3 times per month," one responded "1-3 times per week," and one responded "almost everyday" in the TLC survey.
- Here is how teachers responded to questions in the TLC survey regarding how often the teachers accomplish the following goals:
    - Elicit students' ideas and opinions: Two teachers responded "always" while two responded "very often."
    - Get students to justify and explain their reasoning: Three out of four teachers responded "always," and one said "very often. "
    - Have students relate what they are working on to their own experience: Two teachers responded "always" and two said "very often."
    - When asked in the Teacher Involvement survey how much they anticipate incorporating inquiry activities into their instruction as a result of being a NASA Explorer School, two teachers responded "a little," one responded "some" and one said "a lot."

Guideline 2. Time Intensive.

- "The professional development opportunities have been great. During the school year, I was able to attend conferences in Washington, DC, and bring back activities to share. We would not have had those opportunities if it were not for this program" (Focus Group Interview, May 18, 2006).

[1] Source: NASA Explorer School Digital Portfolios. Retrieved July 20, 2007, from http://aesp.nasa.okstate.edu/efolio

- "We came back and shared the information with grades 2, 3, 4, and 5. I am excited about teaching and bringing in NASA resources" (Focus Group Interview, May 18, 2006).
- "I found that through NASA technology I have also been able to differentiate the lessons better. It has helped me become a more polished teacher" (Focus Group Interview, May 18, 2006).
- "We were lucky when we went to [Field Center J]. We got door prizes and we shared them. We tried to make it a whole school project and vision" (Focus Group Interview, May 18, 2006).
- "As a new NES school, four J22 teachers and the principal were invited to NASA [Field Center J] Research Center in Hampton, Virginia, for a summer weeklong workshop of exciting learning to share with our students and peers."[1]
- "Throughout the year, J22 teachers attended various math science and technology workshops, such as NSTA in Chicago and Nashville, NCTM in Saint Louis, and NECC in San Diego. Teachers also attended the NES Student Symposiums at Johnson Space Center and Goddard Space Flight Center."[1]
- "Two members of the NASA Lead Team at J22 Elementary School attended the regional conference in Omaha, Nebraska. The opportunity enabled us to become more familiar with NASA directives and methodologies for utilizing NASA materials in the general education classroom."[1]

Guideline 3. Classroom Practices.

- "We have subscriptions to magazines and there are articles that are space-related" (Focus Group Interview, May 18, 2006).
- J22's 5th grade special education teacher wants to integrate NASA materials into her classroom and to differentiate the math and science curriculum to help her special education students to be more successful" (Focus Group Interview, May 18, 2006).

Guideline 4. Content Knowledge.

J22 teachers describe how the NES training opportunities have helped them advance professionally,

- "I currently teach second grade and we have received some wonderful programs, had teleconferences with NASA [Field Center J], we have had astronauts here, we have had many teleconferences and personally I've experienced learning about space and about gravity and we've tried to incorporate that into the second grade curriculum. Wonderful questioning techniques, wonderful support systems in place, wonderful hands-on activities as well as students have been using their critical thinking skills.."[1]

- Referring to his/her experience with the Reduced Gravity Jet, another teacher said, "Amazing! That would be our one word reflection. Not just the part of being able to go on the reduced gravity jet was amazing but also what we saw the second grade children come away with in terms of the scientific process and understanding of basic physic principals. In the virtual symposium the second graders were able to explain how it wasn't really zero gravity but was simulated by the parabolas the jet was flying."[1]
- "We were in a constant pedagogical struggle of keeping the science manageable for the students. We were working with second graders. We were introducing them to the concept of gravity. We pushed the envelope to get them to understand anything further. In our data analysis and wrap up summaries with children, we amazed them and ourselves with just how far we came."[1]

Guideline 5. Active Learning.

- "I made my personal development plan align with standards and objectives. We had a crate as a way of monitoring interest" (Focus Group Interview, May 18, 2006).
- As documented in the e-Folio, a 5th grade math teacher talked about how she wants to connect fiction and fantasy in the curriculum to get her students excited about science and math. (e-Folio, 2007).
- "Teachers used many NASA resources to teach the required Virginia Standards of Learning. Please see the digital artifacts for examples from specific lessons."[1]
    - A 5th grade teacher talked about it was difficult to teach students some of the math concepts. Students have better understanding of the differences between weight and mass through some of the NASA provided models and tools.
    - A 5th grade teacher explained about how she incorporates NASA resources into a year long research binder in science. Many areas are covered, not only SOL driven but NASA driven. For example, sound and light. Students show better understanding of some of the science concepts. J22 also has worked with the local planetarium on doing a new program on the school behaves.
- J22 teachers flew student experiments on the Reduced Gravity Jet. "Experiment name: Spinning Toys: Balance and Motion in Microgravity."[1]
- As documented in the e-folio, a pre-school teacher incorporate NASA themes into her curriculum to help students become actively engaged in meaningful activity."[1]

Guideline 6. Coherence.

J22 has developed a partnership with Lockheed Martin which has enhanced the NES implementation. This partnership has thus far involved Lockheed Martin through donating posters, stickers, and pencils for all J22 students, as well as providing guest speakers to meet with both teachers and students during career week activities at the school.

J22 teacher use of technology to support STEM-G has had world-wide impact. The J22 website posted this message: The podcast spearheaded by the J22 team lead, called, Discovery Through a Scientific Lens, is climbing the charts over at Apple's Itunes Music store. Yesterday it was #19 and today it jumps up to #14 in the Educational Technology category.[2]

Teachers describe other factors that helped them be successful in organizing, implementing, and sustaining reform strategies stimulated by NES opportunities.

- "It was very helpful to have the teachers all in the same grade. They are all 5th grade teachers. We were able to meet and talk a lot. We developed a task and everyone would go away and do it. We also divided up by subject matter. One teacher took the science aspect, another took the Math aspect, one took the Language Arts aspect and so on. All students have the opportunity to come to the Discovery Room. We co-teach with other teachers so more of the teachers got information. Teachers decorated outside their classrooms, etc. We were sharing lessons. Even the special education teachers joined the team, unofficially and helped" (Focus Group Interview, May 18, 2006).
- "Helping teachers with integration was easy to do" (Focus Group Interview, May 18, 2006).
- "We have time built into the school year for discussing curriculum. We have shared folders for lesson plans. We have a crate in the Discovery Room so the kids can put things into the crate they make about a topic" (Focus Group Interview, May 18, 2006).
- A J22 teacher described in a video located in the e-Folio that NES provides "wonderful training and opportunities which… have really broadened me as a professional. I currently teach second grade and we have received some wonderful programs, had teleconferences with NASA [Field Center J], we have had astronauts here, we have had many teleconferences and personally I've experienced learning about space and about gravity and we've tried to incorporate that into the second grade curriculum. Wonderful questioning techniques, wonderful support systems in place, wonderful hands-on activities as well as students have been using their critical thinking skills."[1]

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[2] Source: J22 school web site. Retrieved July 20, 2007.

- "Special education teachers work with the grade level teams to integrate the NASA theme into the curriculum for all students. Projects include a reading challenge, a field trip to a Challenger Center, math, writing, music, and art. Listen and watch as students sing, Is there Life on Mars, and animate their digital artwork to the music."[1]

Summary of How J22 Meets Outcome 1.

Professional development has been helpful and useful to J22 teachers. They return to school with great resources and innovative ideas to share with other teachers. The special education teacher can also find curriculum to teach the students which includes the use of technological tools. Teachers were able to align NASA resources with state standards. While it was difficult to teach students some of the math concepts, teachers used NASA-provided models and tools to help students gain better understanding of the differences between weight and mass. Non-NES teachers buy-into the NES. The program is well-received and they have no problems trying new methods of teaching. J22 has documented many NASA activities in the e-Folio.

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

The J22 team purchased the following technologies with NES funding:

- HP Color LaserJet printer, toner cartridges, and ink
- Mitsubishi projector, video, LCD
- Sony Digital Camera Cybershot DSC-W100 (2)
- D520 Dell Computer Notebook
- SmartBoard Interactive Whiteboard and stand
- Latitude D820 Dell Computer Notebook
- Mitsubishi Projector
- Elmo Visual Presenter Document Stand

NASA-sponsored technology has provided new experiences for teachers and students. Teachers are now able to teach lessons creatively, and students participate enthusiastically in the activities that involve technology.

- "I found that through NASA technology I have also been able to differentiate the lessons better. It has helped me become a more polished teacher" (Focus Group Interview, May 18, 2006).
- DLN was a new experience for J22 students. "They [the students] were thinking it was television."[1]
- "Each of the three second grade classes participated in a videoconference about the sun. Later in the year one of the classes had generated so many

questions on chart paper, we arranged for the students to ask their questions via a videoconference. Some of the second graders videoconferenced during the NASA Kickoff Night and two second graders videoconferenced with an astronaut and members of the U.S. Congress. All second graders participated in videoconferences during Hispanic Heritage week with various Hispanic professionals at NASA [Field Center J]."[1]

- The teacher described how her students got really excited when seeing Mars in 3-D and the technology that was used."[1]
- As described by one of the teachers, she had her students write and produce television programs on a variety of NES events. Students also participated in the NES Lights, Camera, and Action competition. The video communication arts teacher provided many opportunities for students to create projects with the NASA theme."[1]
- "NASA activities and lesson plans that were accessible on the web helped the teachers show demonstrations to the children about how the jet simulates zero gravity and teach about friction."[1]

We incorporated some of the data from Teaching, Learning, Computing (TLC) and Teacher Need and Involvement surveys to generate a more inclusive picture of how J22 teachers integrate technology. When teachers were asked how many days a year does a typical student in the class use a computer while they are teaching their class, teachers responded "20-40 times (weekly)" a year. Teachers also responded "16-30 times" for using NASA materials in their classroom in a year.

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

Searching for postings about J22 outreach and family events on the web, we found the following comment from parents of J22 students. Although there were a few negative reviews, the overall average parent rating was positive (4 out of 5).[3]

> "Home of the [Mascot]-[J22} A school where the children are First. We are the village that helps and cares for all! My daughter just graduated from this school and she topped out on the VA SOLS" (September 2006).
>
> "J22 is an excellent school. Both my son and my daughter (kindergarten and second grade) love to go to school. Although, my son had only gone to a two day half day preschool, he felt very comfortable transitioning to the all day, every day routine of kindergarten. That must say something for the staff. The curriculum for him has been outstanding. I only wish my daughter had gone to kindergarten here. We just moved here this year and my daughter had had a hard time in first grade and hated going to school. I ended up having to home school part of the year. I was apprehensive about moving here and placing her in the public school, but her teacher is a true gem. I can't say enough great things about her. There have also been numerous afterschool activities and family events. J22 (Team) truly is the best" (April 2006).
>
> "Overall, I can not fault the school for anything. Excellent teachers and assistants" (April 2006).
>
> "My son recently attended this school (He is a 1st Grader). I have since switched him to another school because we moved. In doing so, I have come to find out that my son is way behind. While he received awards at J22 for being an excellent speller, he can barely keep up with his classmates at his new school. His teacher informed me after him only being there for 2 weeks, that my child is way behind. I am trying to figure out how a student that was doing so well is now behind. The only explanation is that he wasn't being taught at the correct pace. Now it is up to me to bring him up to speed. I am extremely upset" (February 2006).

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[3] The Great Schools website lists overall positive comments from parents of J22 students. (The Parent's Guide to K-12 Success. (1998-2007). Great Schools™. Retrieved May 17, 2007 from http://www.greatschools.net/).

> "The caring and talent of the teachers and the administrative staff is evident the first day your child attends here. The curriculum is taught as creatively as the state SOL's will allow. Teacher and administrators care more about the children learning then test scores. Parent input and involvement is encouraged. Teachers and administrators are actively involved in after school activities and visible at all school functions. Standards of Learning & commitment to quality education are high in Stafford but made manageable by the talented experienced crew at J22. We are thrilled to have our child there. [Teacher] and [Teacher] are awesome" (January 2006).
>
> "My son attended 5th grade here for just a couple of months in 2004, but in those 2 months, my son's teacher showed more concern and caring than any other teacher he has had to date. I was very impressed with all of the support and caring from his teacher, the principal, and the vice principal and other faculty and staff. Wonderful school! I wish I had been able to keep my son there longer! His teacher was a rare gem! All teachers should be like her" (November 2005).

J22 School has provided many activities for the family involvement. Families can conduct the science experiments with their children and also learn science concepts while playing.

- "We had a big kick-off with the whole staff. We bought shirts for every student and teacher. The PTA got involved. We have in-house TV studio so we featured NASA nuggets and did a music video. We infused NASA culture into the school" (Focus Group Interview, May 18, 2006).
- "We have families that choose to come to our school so we wanted to make sure we could be an NES school after the three years" (Focus Group Interview, May 18, 2006).
- During J22's NASA Explorer School Celebration Week and Kickoff Event "Families enjoyed climbing aboard the 53 foot trailer, Space Traveler, to experience 20 hands-on exhibits, explored the cosmos in the Star Lab, observed real moon rocks and meteorites, and visited J22 students' class and science projects throughout the building."[1]

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

J22 teachers have observed changes in students' attitudes toward learning since they have begun to participate productively in STEM-G practices and discourse. Students show curiosity in the STEM-G topics and events, such as checking out more science-related books in the library. The student interest survey showed that students are interested in math and science subjects, and they feel more confident using computers with science data, and using math to explore solutions to problems.

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

Participate productively in STEM-G practices and discourse

- "This is the 4th year with the Jason Project and it was a perfect tie-in" (Focus Group Interview, May 18, 2006).
- "Space Day/Space Week was the perfect time to pursue interesting topics relating to space. Students relived the Cassini mission to Saturn, learned about NASA Spin-offs, investigated "Space Sand," held a Sweet 16 birthday party for the Hubble Space Telescope, and more."[1]

Noticeable curiosity in STEM-G topics and events

- "We had a big kick-off with the whole staff. We bought shirts for every student and teacher. The PTA got involved. We have in-house TV studio so we featured NASA nuggets and did a music video. We infused NASA culture into the school" (Focus Group Interview, May 18, 2006).
- "They are checking out biographies and more science related subject books (out of the library)" (Focus Group Interview, May 18, 2006).
- "It's neat to see kids logging on to NASA as a first choice" (Focus Group Interview, May 18, 2006).
- "Each of the three second grade classes participated in a videoconference about the sun. Later in the year one of the classes had generated so many questions on chart paper, we arranged for the students to ask their questions via a videoconference. Some of the second graders videoconferenced during the NASA Kickoff Night and two second graders videoconferenced with an astronaut and members of the U.S. Congress. All second graders participated in videoconferences during Hispanic Heritage week with various Hispanic professionals at NASA [Field Center J]."[1]

Changes in self-concept

- One of the teachers found that NASA explorations provided opportunities for special needs students to actively participate in science activities."[1]
- "First and second graders talked with NASA [Field Center J] personnel via videoconferencing during Hispanic Heritage Month. The NASA Hispanic employees talked about their careers and childhood learning experiences. They also read stories to the children in English and Spanish."[1]

Attitude changes about learning

- The 2007 All Star Schools report (Hull, 2007) indicates that J22 had mean scores at least one standard deviation above the overall item mean scores on the items listed below. School means and grades are in parentheses beside the school names, and the "top 3" for each item are underlined.
    - "Tell us how much you like …?" English" (3.81, 4-6 grades)
    - "Tell us how much you like …?" Math" (4.00, 4-6 grades)
    - "Tell us how much you like …?" Geography" (3.38, 4-6 grades)
    - "Tell us how much you like …?" Science" (4.06, 4-6 grades)
    - "How well do you think you will do in science this year?" (4.38, 4-6 grades)
    - "Rate how good you are at…?" Using computers with science data (4.40, 4-6 grades)
    - "Rate how good you are at…?" Using math to explore solutions to problems" (4.44, 4-6 grades)
    - "Rate how good you are at…?" Presenting the results of an investigation or project to the class" (4.25, 4-6 grades)
    - "How much would you like to have these jobs…?" Geologist (3.38, 4-6 grades)
    - "How much would you like to have these jobs…?" Engineer (3.63, 4-6 grades)
- "The students are extremely excited! They love it! I had a professional development meeting and the students' activities gave me ideas for lessons. They asked a lot of questions" (Focus Group Interview, May 18, 2006).
- "They talk to me a lot about NASA related information" (Focus Group Interview, May 18, 2006).
- "Being a NASA Explorer School has excited the students, as well as their parents about learning science, engineering, mathematics, problem solving, and technology. The NES coordinator and AES provided ideas for family and community involvement. We received invitations to events that included family of the students, as well as family of the teachers, such

as the premieres of Walk on the Moon 3-D and Roving Mars. The principal and J22 NES team lead write monthly articles for community newsletters such as the Arlington NewsCheck and the Arlington Forrester to share the many NES activities occurring at J22. Many Spanish speaking parents volunteer at J22 on Friday mornings. The J22 Family Coordinator works with these parents on Fridays and talks to them about NES activities occurring in the classroom and outside of school."[1]

- A J22 teacher talked about the improvement in behavior of her students because they get to participate in something related to the NASA space exploration (e-Folio, 2007).

Actively participation in hands-on and authentic scientific research

- "All fourth and fifth graders participated in the Jason Project 'Mysteries of Earth and Mars'. The project is tied in with national standards and it helps students to build the understanding of big ideas" (e-Folio, 2007).

Outcome 5. Increased student knowledge about careers in STEM-G.

Videoconferencing with scientists and astronauts has changed how students see themselves as. They also have better understanding of kinds of NASA 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

- "Each of the three second grade classes participated in a videoconference about the sun. Later in the year one of the classes had generated so many questions on chart paper, we arranged for the students to ask their questions via a videoconference. Some of the second graders videoconferences during the NASA Kickoff Night and two second graders videoconferenced with an astronauts and members of the U.S. Congress. All second graders participated in videoconferences during Hispanic Heritage week with various Hispanic professionals at NASA [Field Center J]" (e-Folio, 2007).
- "Some students reported on Tiger TV wearing flight suits" (e-Folio, 2007).

Increase understanding of and enthusiasm about STEM-G careers

- Lockheed Martin has been a big supporter of J22's designation as a NASA Explorer School. Lockheed Martin has donated posters, stickers, pencils for all of J22's students. Additionally, guest speakers from Lockheed Martin met with students during Career Week" (e-Folio, 2007).

- "We have increased our career exploration. We have had many more opportunities to have scientists and astronauts come in and talk with the children. Because we had the NASA name, we have made Lockheed Martin a partner and they have been good about making the program successful" (Focus Group Interview, May 18, 2006).
- "Each of the three second grade classes participated in a videoconference about the sun. Later in the year one of the classes had generated so many questions on chart paper, we arranged for the students to ask their questions via a videoconference. Some of the second graders videoconferences during the NASA Kickoff Night and two second graders videoconferenced with an astronauts and members of the U.S. Congress. All second graders participated in videoconferences during Hispanic Heritage week with various Hispanic professionals at NASA [Field Center J]" (e-Folio, 2007).
- Through the Jason Project, Jason researcher Kobie Boykins, an engineer at JPL, spoke to J22 students.

- "Retired astronaut and President of Lockheed Martin Space Operations, Ken Reightler and David Brandt, also of Lockheed Martin, will share their experiences with students at J22 elementary schools on Fri, Feb. 24. They will be talking with students about the Mars Mission that is set to reach Mars on March 10 as well as several other NASA/Lockheed Martin space missions" (e-Folio, 2007).
- "Four fifth grade students were selected to represent J22 at the IMAX premiere Walk on the Moon 3-D. Each student brought a parent to the event as well. The students had dinner with astronauts Roger Crouch and Carl Walz before the movie" (e-Folio, 2007).
- J22 participated in a NES Video Conference: NASA [Field Center J] and NASA Johnson Space Center: African American & Hispanic Student Symposium. "NASA Distance Learning LaRC in cooperation with Astronaut Leland Melvin and scientist Byron Meadows video conferenced with students about robotics and lasers on Thursday, June 8, 2006. The one hour broadcast was provided for students in grades 2-5 at NES school J22, in Arlington, VA and Arlington Traditional school joined in the conference. Prior to the conference-symposium, students had a picnic in the park and earlier in the month wrote letters to Astronaut Melvin and Dr. Meadows."[1]

Share information with their peers and parents

- "The [principal], the NASA Team Leader, [Teacher], and fifth grader [Student] were invited to talk with Arlington Public Schools Superintendent about NASA on a local cable television program."[1]
- "We have time built into the school year for discussing curriculum. We have shared folders for lesson plans. We have a crate in the Discovery

Room so the kids can put things into the crate they make about a topic" (Focus Group Interview, May 18, 2006).

- "Four fifth grade students were selected to represent J22 at the IMAX premiere Walk on the Moon 3-D. Each student brought a parent to the event as well. The students had dinner with astronauts Roger Crouch and Carl Walz before the movie."[1]
- "A team of students worked on the Moon Math Challenge for the entire school year. Only two of the students were selected to present their data, research, and multi-media slides. Two students won second place in the nation. They presented their findings in May, 2006, at [Field Center H], in Greenbelt, Maryland."[1]
-

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

In 2004-2005 and 2005-2006, J22 met AYP and the achievement scores were close to the state averages, particularly in science and math. We cannot say firmly that the result is due to NES, but NES definitely plays a major part in students' improvement in these achievement tests.

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

- "One thing that they [the students] got really excited about was seeing Mars in 3-D and that technology that was used."[1]
- J22 teachers flew student experiments on the Reduced Gravity Jet. "Experiment name: Spinning Toys: Balance and Motion in Microgravity:

Children and adults alike enjoy toys. Before our students arrived at school on September 5th, our flight team brainstormed ideas for NASA's Reduced Gravity Jet. Each member of our team brought a unique perspective to the challenge. Our team is comprised of a second grade teacher, a library media specialist, a science specialist, and an instructional technology coordinator. We kept coming back to the idea of experimenting with toys. One flight team member, [Name], was a Hula Hoop champion for the State of Michigan. After initial research, we found that much had already been done with toys in microgravity. However, we noticed that there was an absence of playground toys for elementary-aged students. Toys such as Hula Hoops (playground hoops) and Frisbees (flying discs) would tap into the bodily-kinesthetic needs of young learners. We previewed NASA's International Toys in Space video and

decided to use it as a springboard for more investigation with our second graders at J22. Our students studied balance and motion extensively in first grade. The Virginia Standards of Learning for this first grade strand are as follows:

Force, Motion, and Energy
1.2 The student will investigate and understand that moving objects exhibit different kinds of motion. Key concepts include
a) objects may have straight, circular, and back-and-forth motions;
b) objects may vibrate and produce sound;
c) pushes or pulls can change the movement of an object; and
d) the motion of objects may be observed in toys and in playground activities.

Through experiential learning and teaching we activated our second graders prior knowledge this September and extended these science concepts to a higher level. The National Science Education Standards (NSES) support using curricula that builds on what children already know. Our students were able to combine what they learned last year with the many things they already know about using these toys. Providing connections to prior learning is especially important at J22 because 60% of our students are English Language Learners (ELLs).

The first week of school this year, all the second grade students at J22 watched and experimented with the spinning toys that were tested in NASA's International Toys in Space video. We followed the instructional strategies found in the Video Resource Guide and supported student scientific inquiry as described in the NSES. The students were shown a collection of toys and asked to sort out toys that would create a circular or spinning motion when used. The toys were sorted in the following way by the students:

Spinning Toys and Other Toys
From the group of spinning toys, students selected two to be experimented within our 1-g environment in order to support questioning and making predictions regarding their performance in microgravity. Our second graders eliminated the toys that were already experimented with on the video and selected the playground hoop and the flying disc. [Name] gave an amazing Hula-Hoop demonstration for the students to get them excited about their own investigations to come. This demonstration was shown on our school Tiger TV news broadcast to involve the whole school in this beginning stage of our project."[1]

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

- "Students wrote and produced television programs for the J22 school audience on a variety of NES events. Students participated in the NES Lights, Camera, Action competition. The video communication arts teacher provided many opportunities for students to create projects with the NASA theme."[1]
- Weight vs. Mass Activity: "Students often have difficulty understanding that weight is the force of gravity on an object and mass is the amount of matter in an object. Through hands on/minds on investigation, students obtain a sharper understanding of the concept that just because an object is larger, doesn't mean it weighs more. Students will use 6 different objects and determine the circumference, radius, weight, and other properties using multiple instruments. They will predict which object weighs the most and which object has the most mass. After the exploration of the objects, students will then build their own methods of weighing using only non-conventional weighing devices such as making a pulley or a wheel and axle ramp."[1]

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

- Tables 5 through 7 show a slight increase in math scores in grades 3 and 5, although J22 remains slightly below the state average in most categories. However, grade 5 has shown a 22% increase in math since 2003 and exceeded the state average score by 4% in 2006.

Table 1. School Demographics

	2002-2003	2003-2004	2004-2005	2005-2006
Student population		729*	773*	773**
Black, non-Hispanic		245*	247*	
Asian		24*	27*	
Hispanic		48*	53*	
Indian, Alaskan Native		3*	3*	
White, non-Hispanic		409*	402*	
School location (rural, suburban, urban, mid-size central city)		Urban Fringe of Large City*	Urban Fringe of Large City*	
School type (public, private, charter, magnet)		Public*	Public*	
Title 1 status (yes or no)		Yes*	Yes*	
Free and reduced price lunch		211*	222*	

*National Center for Education Statistics. (2007). Institute of Education Sciences, U.S. Department of Education. Retrieved May 22, 2007 from http://nces.ed.gov/ccd/bat/

**Report Card. (2007). Virginia Department of Education. Retrieved May 22, 2007 from https://p1pe.doe.virginia.gov/reportcard/

Table 2. Summary of Academic Needs Identified by J22 in 2005

Priority	Discipline	Category	National Standard
1	National Science Education Standards	Physical Science	Transfer of Energy
2	National Science Education Standards	Physical Science	Properties and changes of properties in matter
3	National Science Education Standards	Physical Science	Motions and Forces
4	Principles and Standards for School Mathematics	Number and Operations	Understand meaning of operations and how they relate to one another.
5	Principles and Standards for School Mathematics	Problem Solving	Apply and adapt a variety of appropriate strategies to solve problems
6	Principles and Standards for School Mathematics	Data Analysis and Probability	Understand and apply basic concepts of probability
7	Principles and Standards for School Mathematics	Problem Solving	Build new mathematical knowledge through problem solving
8	Principles and Standards for School Mathematics	Reasoning and Proof	Select and use various types of reasoning and methods of proof
9	National Educational Technology Standards		Use content-specific tools, software, and simulations to support learning and research.
10	National Educational Technology Standards		Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum.

Source: J22 Needs Assessment. (2004).

Table 3. NASA Professional Development Opportunities that J22 Teachers Completed

Conferences in Washington, DC
2005 Summer Orientation (LARC, Hampton, VA)
2005 NSTA (Chicago, IL)
2005 NSTA (Nashville, TN)
2005 NCTM (St. Louis, MO)
2005 NECC (San Diego, CA)
2005 NES Student Symposium (JSC and GSFC)
NASA Mathematics Workshop (Cleveland, OH)

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 4. NASA Resources and Expertise That J22 Teachers Incorporated into Their Instruction

NASA AES
NASA Funding
NES Coordinators
NASA Educator Resources
Jason Project
DLN presenters and website
NASA Websites
NASA posters, lithographs, stickers
NASA astronauts, engineers, and other personnel
NASA Moon Math Challenge
NASA DLN event on Mars
Animations from NASA websites
NASA activities from the summer workshop
NASA astronauts, engineers, and representatives
Virginia Science Museum classroom workshops, StarLab planetarium, and Space Travelers trailers
Curriculum Guide-Microgravity
NASA Video-International Toys in Space
Regional Conference (Omaha, NE)
Lessons from Summer 2005 [Field Center J] Training

Source: 2006 Spring Team Interview; Spring 2006 Team Lead Survey; and Fall 2005 Team Lead Survey

Table 5. J22 SOL Grade 3 Scores

	English: Reading	Science	Math
2003	73%	82%	86%
2004	67%	80%	83%
2005	68%	76%	74%
2006	74%	88%	84%
State Average in 2006	84%	90%	90%

Source: SOL Results. (2005-2006). Virginia Dept. of Education. Downloaded 05-18-2007 from http://www.pen.k12.va.us/

Table 6. J22 SOL Grade 4 Scores

	English: Reading	Science	Math
2006	84%		79%
State Average in 2006	86%		77%

Source: SOL Results. (2005-2006). Virginia Dept. of Education. Downloaded 05-18-2007 from http://www.pen.k12.va.us/

Table 7. J22 SOL Grade 5 Scores

	English: Reading	Science	English: Writing	Math
2003	81%	82%	88%	65%
2004	80%	79%	84%	74%
2005	81%	85%	97%	81%
2006	87%	86%	84%	87%
State Average in 2006	87%	85%	86%	83%

Source: SOL Results. (2005-2006). Virginia Dept. of Education. Downloaded 05-18-2007 from http://www.pen.k12.va.us/

NASA Explorer Schools
Case Study Schools Report Rubric
2005 Cohort

		2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
	Maximum Possible Points	**A104**	**B72-A**	**B72-B**	**C14**	**D143**	**E25**	**F59**	**G110**	**H6**	**I38**	**J22**
TOTAL SCORE	**102**	**63**	**81**	**81**	**65**	**61**	**71**	**74**	**62**	**77**	**72**	**88**
<u>Outcome 1:</u> Participation and professional growth of educators in science	**48**	**33**	**43**	**43**	**34**	**33**	**34**	**36**	**31**	**40**	**35**	**41**
Guideline 1 - Instructional Strategies *[data sources*: interview transcripts; surveys: TI, Adm, TLC; e-folio]*	8	5	6	6	5	6	7	5	5	8	7	7
Guideline 2 - Time Intensive *[data sources: interview transcripts; surveys: TL, TI, FC; e-folio]*	8	6	7	7	7	5	6	6	5	6	5	6
Guideline 3 - Classroom Practices *[data sources: interview transcripts; surveys: SI, TL, TI, FC; e-folio]*	8	6	7	7	7	6	7	6	5	6	5	6
Guideline 4 - Content Knowledge *[data sources: interview transcripts; workshop reports; surveys: TL, TI, FC; Admin; e-folio]*	8	5	7	7	3	5	5	6	6	6	6	7
Guideline 5 - Active Learning *[data sources: interview transcripts; workshop reports; surveys: TI, FC; Admin; e-folio]*	8	6	8	8	5	5	6	7	5	7	7	8

		2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
	Maximum Possible Points	**A104**	**B72-A**	**B72-B**	**C14**	**D143**	**E25**	**F59**	**G110**	**H6**	**I38**	**J22**
TOTAL SCORE	**102**	**63**	**81**	**81**	**65**	**61**	**71**	**74**	**62**	**77**	**72**	**88**
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	5	8	8	7	6	3	6	5	7	5	7
Comments on Outcome 1:												
<u>Outcome 2:</u> Assistance for and technology use by educators in schools with high populations of underserved students	**16**	**5**	**12**	**12**	**7**	**8**	**10**	**7**	**7**	**8**	**9**	**13**
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	4	4	4	3	4	3	3	3	4	4
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	1	4	4	2	3	3	3	1	3	2	4

		2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
	Maximum Possible Points	**A104**	**B72-A**	**B72-B**	**C14**	**D143**	**E25**	**F59**	**G110**	**H6**	**I38**	**J22**
TOTAL SCORE	**102**	**63**	**81**	**81**	**65**	**61**	**71**	**74**	**62**	**77**	**72**	**88**
Guideline 3 - Teachers report frequency of using the technology in STEM-G context [data sources: interview transcripts; surveys: TLC; e-folio]	4	1	2	2	1	1	2	1	1	1	2	2
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	0	2	2		1	1	0	2	1	1	3
Comments on Outcome 2:												
<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**	**9**	**8**	**8**	**5**	**8**	**8**	**7**	**9**	**9**	**6**	**8**
Comments on Outcome 3:												
<u>Outcome 4:</u> Student interest and participation in science, technology, engineering, mathematics, and geography	**8**	**5**	**7**	**7**	**6**	**6**	**7**	**7**	**4**	**7**	**7**	**8**

		2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
	Maximum Possible Points	**A104**	**B72-A**	**B72-B**	**C14**	**D143**	**E25**	**F59**	**G110**	**H6**	**I38**	**J22**
TOTAL SCORE	**102**	**63**	**81**	**81**	**65**	**61**	**71**	**74**	**62**	**77**	**72**	**88**
Guideline 1 - Participate productively in STEM-G practices and discourse *[data sources: interview transcripts; e-folio]*	2	1	2	2	2	2	2	2	1	2	2	2
Guideline 2 -Show noticeable curiosity in STEM-G related topics and events *[data sources: interview transcripts; surveys: TL, TI, FC; e-folio]*	2	1	2	2	1	1	1	1	1	1	2	2
Guideline 3 -Change attitudes about learning *[data sources: interview transcripts; surveys: SI; e-folio]*	2	1	1	1	1	1	2	2	1	2	1	2
Guideline 4 -Actively participates in hands-on and authentic scientific research *[data sources: interview transcripts; surveys: SI; e-folio]*	2	2	2	2	2	2	2	2	1	2	2	2
4.3: Did not take student interest survey							4.3 Teachers report that students are excited about learning, but					
<u>Outcome 5:</u> Student knowledge about careers in science, technology, engineering, mathematics, and geography	**9**	**4**	**5**	**5**	**6**	**2**	**5**	**7**	**2**	**6**	**7**	**9**
Guideline 1 - Change in self-identity *[data sources: interview transcripts; surveys: SI; e-folio]*	3	2	3	3	3	1	1	3	2	3	2	3

		2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
	Maximum Possible Points	**A104**	**B72-A**	**B72-B**	**C14**	**D143**	**E25**	**F59**	**G110**	**H6**	**I38**	**J22**
TOTAL SCORE	**102**	**63**	**81**	**81**	**65**	**61**	**71**	**74**	**62**	**77**	**72**	**88**
Guideline 2 -Increased understanding of and enthusiasm about STEM-G careers *[data sources: interview transcripts; surveys: SI, TI; e-folio]*	3	1	1	1	1	1	2	1	0	1	2	3
Guideline 3 -Share information with peers and parents *[data sources: interview transcripts; surveys: SI; e-folio]*	3	1	3	3	2	2	3	3	0	3	2	3
5.2, 5.3: Did not take student interest survey												
<u>Outcome 6:</u> Student ability to apply science, technology, engineering, mathematics, and geography concepts and skills in meaningful ways	**9**	**5**	**5**	**5**	**6**	**4**	**7**	**8**	**9**	**7**	**7**	**9**
Guideline 1 - Understand and use scientific explanations of the natural world *[data sources: interview transcripts; surveys: SI, TI, FC; e-folio]*	3	2	2	2	2	2	2	3	5	3	2	3
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	2	2	2	2	3	2	2	2	2	3

		2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
	Maximum Possible Points	**A104**	**B72-A**	**B72-B**	**C14**	**D143**	**E25**	**F59**	**G110**	**H6**	**I38**	**J22**
TOTAL SCORE	**102**	**63**	**81**	**81**	**65**	**61**	**71**	**74**	**62**	**77**	**72**	**88**
Guideline 3 - Increased achievement in math and language arts, reading, and science standardized tests *[data sources: interview transcripts; State report card data]*	3	1	1	1	2	0	2	3	2	2	3	3
Comments on Outcome 6:		6.3: A104 moved from not meeting AYP to Provisional in 2004-05. 9th and 11th	6.3: B72-A did not meet AYP; Only grade 3 math scores exceed state math scores;	6.3: Grades 5 & 6 exceed state math scores; Grades 3 & 4 are below state math			6.3 Met AYP, but math scores remain below state scores and have decreased		1	6.3 Met AYP. Math scores for grades 5 & 6 are above state average. Grade 7	6-3 Met AYP. Grades 3 & 4 math scores have improved and exceed state averages	6.3 Meets AYP. Grade 5 shows a 22% increase in math since 2003 although they
Bonus Points: *Great School Rating* ***www.greatschools.net/***	**2**	**2**	**1**	**1**	**1**	**0**	**0**	**2**	**0**	**0**	**1**	**0**
*Definition of Data Sources												
Interview transcripts:												
2003 NES school teams were interviewed in the spring of 2005												
2003, 2004, and 2005 cohort case study school teams were interviewed in the spring of 2006												
Surveys:												
SI: Student Interest - taken by case study schools, spring 2006												
TL: Team Lead - taken by all NES team leaders, spring 2006												
TI: Teacher Involvement - taken schoolwide by NES and non-NES teachers at all NES schools, spring 2006												
FC: Field Center Staff - disseminated to field center education staff at all 10 NASA centers, spring 2006												
Admin: Administrator - completed by NES team administrators, spring 2006												
e-folio: An electronic portfolio for the NASA Explorer Schools project <http://aesp.nasa.okstate.edu/efolio/>												