Evaluation of NASA Explorer Schools, Findings from Year 1

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Executive Summary

The NASA Explorer Schools (NES) project provides middle and high school students with authentic learning experiences that are inspired by NASA's missions. The NES project consists of four primary components, available on the project's website:

- STEM curriculum support modules designed for middle and high school teachers.
- Electronic professional development (ePD) that assists in the implementation of the STEM curriculum support modules.
- NASA Now events that offer firsthand accounts of new discoveries and mission updates from NASA scientists and engineers.
- Recognition opportunities for students, teachers, and schools that allow NES to highlight exemplary use of best practices.

In 2010, NASA contracted with Abt Associates Inc. and its subcontractor, the Education Development Center, Inc. (EDC), to design and conduct a national formative evaluation of the NES project whose findings could be used to guide project improvements and that would provide insight into project-related teacher and student outcomes. Between April and June 2011, Abt and EDC conducted 86 interviews with NES registered users; these included 20 conversations at the Student Symposium and 66 phone interviews using 9 different protocols. Registered users span a wide range of backgrounds and educational settings, which simultaneously reflects the success of NES recruitment and poses challenges to NES support of teachers. The information on actual use of NES resources was drawn from across the 1,503 users who had registered as of June 1, 2011; NES records indicate that over 1,700 individuals ultimately registered through the end of July 2011. The data for this evaluation was collected through completed surveys and interview data; these data suggest that many, although not all, registrants are implementing NES. The data further suggest that teachers who used NES materials were satisfied overall with the NES project.

Participants selected NES materials based on the relevance to their individual curriculum, and modification of the materials was common. Educators looked to NES to provide supplemental teaching materials, and thus selected modules that aligned with their curriculum. Some teachers used each of the NES components—modules, ePD, and NASA Now events—while others were selective in what they implemented. Suggestions for improvement were often related to very specific needs of the individual educator. By virtue of the program's design, the individuals who participate in NES are a self-selected group who are typically motivated to find materials to augment their instructional curriculum. Study participants reported that the NES project offered valuable resources, and users were able to identify benefits of NES participation that accrued both to themselves and to their students.

The study also identified some challenges that the NES project faces as it moves forward, related to the distinction between NES and what is available more generally through NASA education. Individuals who had registered for NES were not always able to distinguish what they accessed through NASA more generally from what they accessed through NES, and some raised questions about the value-added of NES above what was available more generally through NASA. Finally,

teachers were not systematically employing the best practices identified by NES, and it was not clear that the recognition opportunities served as motivators to engage in these practices. These themes will be further explored in Year 2 of the evaluation.

1 Introduction

The National Aeronautics and Space Administration (NASA) contributes to the nation's science, technology, engineering, and mathematics (STEM) education through a portfolio of projects—spanning precollege (K-12), informal, and higher education—designed to strengthen the nation's future workforce, attract and retain students in STEM disciplines, and engage citizens in STEM and in NASA's mission (NASA, 2011a). Through its education portfolio, NASA aims to: increase elementary and secondary education participation in NASA projects; enhance higher education capability in STEM disciplines; increase STEM participation by underrepresented and underserved communities; expand eEducation; and expand NASA's participation with the informal education community (NASA, 2011b).

The NASA Explorer Schools (NES) project supports NASA's efforts to inspire, engage, and educate America's K-12 students by providing middle and high school students with "authentic learning experiences inspired by NASA's unique missions" (NASA, 2011b). The NES project, along with most of NASA's K–12 efforts, aligns with the national goal of engagement in STEM fields, as defined by the Academic Competiveness Council, to "increase students' engagement in STEM and their perception of its value to their lives" (U.S. Department of Education, 2007).

NASA contracted with Abt Associates Inc. and its subcontractor, the Education Development Center, Inc. (the Abt team) to design and conduct a national formative evaluation of the NES project. This report summarizes the findings from Year 1 of this evaluation. We begin with an overview of the NES project and the program theory, describe the methodology used in this evaluation, present the findings related to the implementation of the NES project, and present a discussion of cross-cutting themes and the conclusions drawn from this study.

Overall, the study found that teachers who used NES materials were satisfied with the NES project and suggestions for changes were often very specific to the needs of the individual educator. By virtue of the program's design, the individuals who participate in NES are a self-selected group who are typically motivated to find materials to augment their instructional curriculum. Study participants reported that the NES project offered valuable resources, and users were able to identify benefits of NES participation that accrued both to themselves and their students. Participants selected NES materials based on the relevance to their individual curriculum, and modification of the materials was common. The study also identified some challenges that the NES project faces as it moves forward. Namely, individuals who had registered for NES were not always able to distinguish what they accessed through NASA more generally from what they accessed through NES, and some raised questions about the value-added of NES above what was available more generally through NASA. Finally, it appeared that teachers were not systematically employing the best practices identified by NES, nor that the recognition opportunities served as motivators to engage in these practices.

1.1 The NES Project

Following recommendations from the National Research Council (NRC) committee that reviewed NASA's elementary and secondary education projects (NRC, 2008), NASA redesigned the NASA

Explorer Schools (NES) project beginning in 2008. The NES project aims to link STEM classroom topics to real-world NASA activities in an effort to develop students' interest and aptitude in STEM disciplines (NASA, 2011a). Individual teachers and administrators are able to register for the NES project each year to access NES materials and participate in NES activities.

NES seeks to prepare students in STEM and inspire them to pursue STEM careers, or at a minimum, become part of a STEM-literate citizenry. Thus, the current NES model is well aligned with the recent President's Council of Advisors on Science and Technology (PCAST) report, *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future*, which concluded that to improve education in STEM, the country needed to focus on both the preparation and inspiration of students (PCAST, 2010).

The NES project consists of four primary elements, all available on the project's Virtual Campus website (http://www.nasa.gov/offices/education/programs/national/nes2/home/index.html). These elements include:

- **STEM curriculum support modules**. These modules are designed for middle and high school teachers to implement in their classrooms. They are developed around NASA's research and scientific discoveries.
- **Electronic professional development (ePD)**. These online professional development sessions are designed to assist teachers with implementing the STEM curriculum support modules. They are available in both live and on-demand formats.
- **NASA Now events**. These weekly events offer firsthand accounts of new discoveries and mission updates directly from NASA scientists and engineers. They are delivered live through webcasts and facilitated online discussions.
- **Recognition Opportunities**. These opportunities allow NES to highlight exemplary use of best practices in education to inspire student interest in STEM disciplines. Opportunities are available for students, teachers, and schools. For teachers and schools these include expense paid trips that offer research experience and professional development; for students, these are expense paid trips where they have the opportunity to present to their peers and NASA staff their in-depth investigations.

1.2 NES Project Development and Evaluation

1.2.1 Pilot Test

To address the evaluation needs of the NES project, NASA developed an evaluation plan that began with data collection and program feedback during a pilot-testing phase. The information collected during this pilot study, conducted in 2009, was used to compile a list of "lessons learned" and recommendations, which were addressed prior to full implementation of the project in the fall of 2010. The key specific recommendations and resulting program modifications are detailed below:

Curriculum Selection: A review of the process used to select NES materials for the pilot indicated that some high-quality NASA education products were overlooked. Therefore, NES staff developed a new process for internal review of NASA standards-based learning materials. Among considerations

in the new process were the primary and secondary subject areas, the presence of inquiry-based learning tasks, and the higher-order thinking skills involved in the activity. Once new materials were identified, outside educators conducted external reviews to evaluate selected featured lessons on criteria including: classroom relevance, cross-cutting STEM ability, analytic rigor, ease of use and curriculum flexibility, expected student engagement, and teacher appeal. In total, 10 new NES lessons were added to the project for Year 1 implementation, in addition to the 10 lessons originally selected for the pilot.

Classroom Video: Researchers found that teachers used the ePD videos with students to demonstrate activities or present information. Therefore, NES staff designed video segments specifically for classroom use and highlighted additional NASA video clips as supplemental resources that could be used in the classrooms.

NASA Now Events: Teacher feedback from the pilot study indicated that the NASA Now videos (known then as "virtual breaking news" segments) could better engage students. NES therefore reworked and rebranded the videos into 7-10 minute, standards-aligned video segments that showcased NASA careers in action. NES staff also made an effort to include more dynamic and exciting video clips in order to engage students. Additional changes to the video events included: the inclusion of pre- and post-questions, highlighting key information for the video on each event's webpage, developing more targeted videos for specific subjects and grades, providing more coaching to the subject-matter experts who appeared in the videos in order to ensure that they used age-appropriate language and were engaging, providing links to related events, and holding live chats.

ePD: In the pilot phase, there were three types of ePD videos: on-demand, live, and facilitated. In response to participant feedback, the live sessions were eliminated in Year 1, and facilitated sessions were re-labeled as "live ePD." Additional changes to the ePD videos included: splitting videos into segments, clarifying titles of individual clips, using a higher resolution player, offering credit for PD, and providing links to additional PD opportunities. After the pilot, NES allowed teachers to receive credit for participating in ePD opportunities. Additionally, NES enhanced its connection with the National Science Teachers Association (NSTA) learning center to provide users with additional ePD resources at no cost.

Curriculum Use: There was an increase in teachers' use of NES lessons as Year 1 progressed, especially between January and March (a time period which coincided with NES announcements of recognition opportunities). However, the pilot study revealed issues surrounding the identification and modification of appropriate classroom materials. For instance, teachers expressed the need to more easily identify appropriate lessons for their classroom. To respond to this need, NES streamlined each lesson page and provided specific information for each lesson, such as the target grade level, subject(s) covered, instructional objective, estimated completion time, etc. NES staff also developed narrower grade ranges for various materials, including the NASA Now videos and Featured Lessons. These grade levels and description pages have been continuously reviewed as the project has progressed.

The pilot study also found that many NES users made modifications to the materials (to adjust for grade level, student ability, etc.), and they expressed a desire for assistance with these modifications. In response, NES staff have implemented some measures to assist with modifications, such as providing ideas for how resources can be used with different audiences during the live webinars, directing users to the NEON site, where teachers are encouraged to share modifications with other users, and providing teachers with information on common misconceptions in order to give them ideas for addressing student concerns or questions. Additionally, NES staff have provided feedback to curriculum developers about the need for flexible materials and modification instructions; however, final decisions regarding changes to NASA materials are beyond the scope of the NES project.

Recruitment: During the pilot study, NES worked with state Math and Science Partnerships to recruit new users; this proved to be successful at the time, however, these partnerships were not pursued during Year 1. Instead, NES focused on two different recruitment strategies: peer-to-peer recruitment and recruitment at professional conferences. The peer-to-peer recruitment campaign provided teachers with materials to share with colleagues in an effort to recruit new users. This campaign was responsible for 25.5 percent of the total Year 1 registration. Additionally, NES staff refined their recruitment pitches for use at professional conferences, which attracted more new NES users. Overall, more than 1,700 users registered for NES in Year 1.

Alignment to Standards: NES content was aligned to national standards for the pilot program. However, many users expressed a desire to have content aligned to state standards, which teachers are responsible for closely following. While this need was discussed, ultimately NES was unable to align content to state standards for Year 1 implementation, mainly due to budgetary constraints. Working with partners (particularly NSTA) to align content is something that NES hopes to pursue in the future, should funds allow for it.

Participant Support: During the pilot program, one NES staff member was responsible for providing user support. Support mechanisms and staffing were increased as a result of pilot study feedback in Year 1. For instance, NES created a Help Desk, which consisted of a dedicated phone number and email address which teachers could use to contact program staff between 8:00 am and 8:00 pm every day (excluding federal holidays). At the end of Year 1, staff implemented a targeted communications campaign which provided specific tips, reminders, and resources to users based on their profile, and which directed teachers to the various social media resources for additional support. Finally, live office hours were implemented, but not widely utilized, in Year 1. The majority of questions fielded by the help desk in Year 1 were technical in nature, rather than questions regarding the content or implementation of the materials.

Social Networking: The pilot study found that the social networking tools were underutilized by NES teachers. In response to these findings, NES promoted its various social networking tools to encourage participation, specifically by adding links to the NES social media sites throughout the virtual campus. Staff strengthened the NEON forum in various ways; for instance, implementation ideas were collected through NEON in Year 1, rather than through online comment boxes. However, social networking tools are still underutilized, and NES staff are continuing to attempt to help users learn how to interact with the various tools. Additionally, budgetary uncertainties forced a later roll -

out of various elements of the virtual campus, which contributed to the limited use of social networking tools in Year 1. The strategy for promoting social networking tools in Year 2 continues to be refined.

Timing and Implementation: One result of the pilot study was that many teachers were unable to implement NES materials as intended because they enrolled in the program later in the school year. A recommendation set forth by researchers was to limit the enrollment window; however, NES did not implement this suggestion in Year 1. As mentioned earlier, the Virtual Campus was still in development during the beginning of Year 1 as well, which likely slowed implementation for some users. However, staff have started to consistently emphasize the importance of up-front planning to encourage teachers to incorporate NES materials into their curriculum. For instance, staff implemented a communication campaign during summer 2011 to encourage teachers to review NES materials over the summer. Now that all the pieces of the Virtual Campus are in place, NES staff anticipate fewer issues related to timing and implementation in Year 2.

1.2.2 Year 1 Evaluation (2010-2011)

The next phase of the evaluation plan, which focused on gathering data primarily for program improvement and modifications, involved an independent evaluator (the Abt team) to gather formative feedback and collect data on related outcomes. A secondary goal of the formative phase was to begin exploring whether there is preliminary evidence that desired teacher and student outcomes are being observed. A subsequent phase of the evaluation plan includes an impact study, in order to determine whether changes in teacher and student outcomes have actually occurred, and whether these changes are due to the NES project. This report presents findings from the first year of the formative evaluation.

The Abt team collected user data designed to explore the structures and processes of NES and the implementation of project components. The purpose of the evaluation was to gather information regarding whether the NES intervention is being implemented as intended. For example, because the program involves teachers participating in training (e.g., NES's ePD), employing particular instructional strategies with their students through the use of program materials (e.g., NES curricular modules) and presenting particular instructional content to students (e.g., NASA Now events), the process study investigated the extent to which teachers implemented each of those components. Data on implementation, as well as self-reported information on preliminary evidence of teacher and student outcomes, were collected through a series of teacher interviews conducted in spring 2011.

1.2.3 Year 2 Evaluation (2011-2012)

The formative evaluation will continue during the 2011–2012 school year. In addition to implementation data (which will include real-time data collected through teacher logs), data will be gathered to investigate whether changes in the intended outcomes of the program are present among project participants. The evaluation will use a one group, pre-post design to gather data from teacher and student participants to see whether there are changes in intended outcomes as measured before and after participation in the NES project. The gathering of outcome data will lay the groundwork for decisions about additional evaluation steps for the NES project. For example, data may reveal that program participants show pre-post gains on the science attitudinal outcomes

that the program is designed to boost. If the intended outcomes are present, a more rigorous impact evaluation could be designed to test whether the changes are due to the NES project.

1.3 The NES Program Theory

The NES program theory builds on what the field considers good education practices and important outcomes. NES seeks to build student interest and engagement in STEM by involving students in NASA-related STEM activities in classrooms, and supporting teacher use of the materials. To help engage students in STEM, NES provides NASA-developed STEM curriculum support materials and NASA Now video events for use in STEM classrooms. NES provides ePD to train teachers on the use of the NES materials and the related STEM content. To promote the use of best practices, NES recognizes teachers' and schools' use of best practices in the areas of curriculum integration, student engagement, technology use, community outreach, and family involvement.

NES materials are designed to engage students actively with STEM content. When teachers employ active learning strategies, students have the opportunity to problem-solve in a hands-on setting and collaborate with others to share ideas and strategies (Sirinterlikci, Zane & Sirinterlikci, 2010). Active learning encourages the development of communication skills, higher-level thinking skills, a positive attitude towards the subject, and increased motivation to learn (Sirinterlikci et al., 2010). In recent studies, high school students reported better understanding of math and science concepts when they were presented to the class in the context of solving a problem or building a model (Merrill, Custer, Daughtery, Westrick & Zhang, 2008). Middle school camp participants rated hands-on, laboratory-based engineering workshops as improving their understanding of the subject, as well as being engaging and enjoyable (Dave, Blasko, Holliday-Darr, Kremer, Edwards, Ford, et al., 2010).

Exhibit 1 graphically displays the initial NES program theory, which helped guide the evaluation activities. Moving from left to right, the model shows the links between the project inputs and activities through NES's intended short-term and long-term outcomes. The model is discussed below.

1.3.1 Inputs and Activities

NES Inputs and Activities

The NES project is run by staff from NASA and partners who have been involved in the design and implementation of various components of the NES project. The NES Virtual Campus website is the central hub for the project; it provides the interface between the NES project and teachers. NES, with its strategic partners, is involved in advertising the NES project in order to increase visibility and recruit teachers and schools to participate. Teachers sign up to participate via the NES Virtual Campus where they can also access the NES curriculum materials, ePD training, and NASA Now events. The Virtual Campus also contains links to the NES social networking components and other STEM-related opportunities.

In the 2010–2011 academic year, NES offered 20 NASA-developed modules for middle and high school teachers to use as supplementary materials in their STEM classrooms. The curriculum modules were selected for potential student and teacher appeal, classroom relevance and grade appropriateness, applicability across STEM areas, intellectual rigor and incorporation of scientific

inquiry or engineering design, and ease of use and flexibility. To assist with the use of these materials, NES provides teachers with content and implementation training on the NES curriculum modules via on-demand video ePD segments and live interactive ePD webinars. This training is further enhanced by a Help Desk.

In addition, NES offers NASA Now events related to ongoing NASA research and programs. The videos are intended to be used by teachers in classrooms to engage students and expose them to NASA-related content, missions, and careers. NES also fosters the development of teacher communities through the moderation of online collaborations and access to social networking tools (e.g., NASA Educators Online Network (NEON)).

Another component of the NES experience is the recognition program structured to recognize the expression of best practices among participants. This program identifies best practices in five areas: curriculum integration, student engagement, technology use, community outreach, and family involvement. NES hopes to motivate teachers in each of these areas by highlighting them in the NES recognition program.

Teacher Inputs and Activities

Teachers self-select into the program and so bring their own motivation and desire to participate. As participants they contribute time to plan and implement curriculum modules, view ePDs, and participate in the recognition program. They also communicate with other teachers through social networking sites, which may assist the establishment and growth of NES and NASA teacher networks. Teachers may also promote NES among their colleagues, thus broadening the participation in NES and laying the groundwork for networks.

Teachers drive the use of the NES materials, both modules and NASA Now, in the classroom. Although NES modules identify the materials that are necessary to implement a unit, teachers provide the supplies for activities as necessary. Also, teachers provide feedback to the NES project via surveys that correspond to the individual project components. Finally, schools and teachers provide the technology necessary to access the NES products and use them in classrooms.

Partner Inputs and Activities

Strategic partners—external stakeholders who collaborate with NES to support the model—also serve an integral role in NES. Partners provide reviewers to validate and make the final selection of curriculum modules. Partners also provide access to networks of teachers and they assist in the recruitment of teachers to NES via these established networks. In addition, the NES Virtual Campus provides links to resources that strategic partners offer, so that NES teachers and students have access to resources that extend beyond the NES project.

Exhibit 1: Logic Model Depicting NASA Explorer Schools' Program Theory of Change

1.3.2 Outputs

NES outputs can be measured at the student, teacher, and school levels. These outputs include the number of teachers, students and schools that participate in NES and in particular activities. At the student level, outputs include the number of students engaged in NES through teachers' use of curriculum modules and NASA Now events in classrooms. It is expected that a subset of NES students will apply for and be selected to participate in the recognition program, therefore additional student outputs include the number of students who apply for and participate in the recognition program.

Teacher outputs include the number of teachers enrolled in the NES project. NES expects that enrolled teachers will participate in the ePD related to the curriculum modules and will then use the NES modules in their classrooms. These teachers will complete the surveys related to the curriculum modules, ePDs, and NASA Now events they use. NES teachers will also demonstrate elements of the best practices identified by NES. A subset of NES teachers will access the linked resources from the NES website and a subset of those teachers will then apply for and attend the NES recognition opportunities. Additional outputs include the number of teachers engaged in each of these NES components.

NES is designed so that participation can occur at the school level. Therefore, a school-level outcome is the number of schools with multiple teachers participating. These schools will demonstrate the integration of NES beyond a single classroom and the use of best practices. Additional outputs include the number of these schools that apply for and participate in the NES recognition program.

1.3.3 Short-Term Outcomes

Following the program theory, if teachers and schools are implementing NES as intended, then the inputs and activities will result in the expected outcomes for students and teachers described below. The importance of these outcomes is supported by in empirical studies.

Students

Students should have more positive attitudes about STEM, increased self-efficacy in STEM areas, increased interest in STEM careers and educational opportunities, and increased access to other NASA opportunities. All of these outcomes are supported by the curriculum modules and NASA Now events, which are designed to create opportunities for students to engage positively with STEM content around NASA themes, engage them in the inquiry process, and expose them to NASA content, scientists, and careers. Students' increased access to and participation in other NASA opportunities is further supported by the NES recognition program and via participating teachers and schools.

A number of factors are associated with students' maintained participation in STEM disciplines, and ultimately, their pursuit of STEM careers. At the root of these factors is student interest in STEM. A number of studies point to the importance of fostering a strong individual interest in a subject or activity for the interest to persist and translate to achievement (Hidi & Renninger, 2006; Schiefele, Krapp & Winteler, 1992; Watt, Eccles, & Durik, 2006). Related to students' interest in STEM subjects is their self-efficacy, or perceived ability to carry out a task (Bandura, 1993). High self-efficacy in

academic subjects has consistently been found to correlate with future course enrollment and career aspirations (Bandura, Barbaraneli, Caprara & Pastorelli, 2001; Betz & Hackett, 1983; Lent, Brown & Larkin, 1986; Simpkins, Davis-Kean & Eccles, 2006; Watt et al., 2006). For instance, in a study by Simpkins et al. (2006), 6th graders who exhibited high self-efficacy in math or science went on to complete more math and science courses in high school. A 1988 National Educational Longitudinal Study (NELS 1988) found that students' self-efficacy was more predictive of prolonged interest in STEM careers than academic proficiency in such subjects (Mau, 2003).

Student lack of interest can be attributed to a number of factors, but of particular importance, experts note that students are not being exposed to enough relevant STEM topics during elementary, middle, and high school (Rockfield, Bloom, Carpinelli, Burr-Alexander, Hirsch, & Kimmel, 2010). Further, many high school students do not ever reach proficiency in math and science, and many 2009 graduates were missing only the required science courses to reach the next highest curriculum level (Congressional Research Service, 2006; Nord, Roey, Perkins, Lyons, Lemanski, Brown & Schuknecht, 2011). Once students reach college, almost 30 percent are required to take remedial science and math courses because they are not prepared to engage with college-level STEM content (National Science Board [NSB], 2007). International benchmarks, such as the Programme for International Student Assessment (PISA) test, confirm that students in the U.S. lag behind their peers in industrialized nations in STEM critical thinking skills (NSB, 2007).

Enrollment in math and science courses in high school is correlated with higher rates of entry into postsecondary educational institutions; 88 percent of high school students in two or more advanced math courses and 90 percent of those in two or more advanced science courses enrolled in a 4-year college within 2 years of high school graduation, in comparison to their peers without advanced credits (NSB, 2010). Additionally, students who take more math and science courses while in high school are more likely to choose a STEM-related major in college (Federman, 2007). Thus, it is imperative that high-quality, relevant STEM-related coursework is accessible to students at all levels in order to increase interest in STEM.

Teachers

Teachers themselves should be better able to implement and use NES products, have an increased familiarity and confidence with NES STEM materials and content, integrate these products into their curriculum, and use best practices relating to curriculum integration, student engagement, technology use, community outreach, and family involvement.

The support that NES offers teachers in implementing materials is particularly important in STEM classrooms, where not all teachers have the necessary background or preparation for the disciplines they teach. Experts note that "the nation faces a chronic shortage of qualified teachers who are adequately prepared and supported to teach STEM disciplines effectively" (NSB, 2007). Teachers are often unable to acquire sufficient STEM content knowledge and/or pedagogical skills during their pre-service education, and many teachers lack adequate classroom support during their first years of teaching (e.g., mentoring, professional development). Data also demonstrate that many teachers are assigned to subjects without the necessary background and preparation to teach them, making them, by definition, unqualified (Ingersoll, 2005). For instance, in the 1999–2000 school year, 24 percent of core classes in public school grades 7–12 were being taught by teachers without a major

or a minor in the subject field (Ingersoll, 2003). In a study by Subotnik, Edmiston and Rayhack (2007), researchers reported that only 68 percent of secondary students were taught by a qualified mathematics instructor and less than 40 percent of students had a qualified chemistry teacher or certified physics teacher. It is therefore important to provide teachers with materials and support, in order for them to exhibit increased confidence and competence with these important STEM topics.

The NES materials were selected through a systematic process that was designed to identify high-quality materials that were appropriate for and engaging to middle school and high school students in STEM classrooms. The NES Virtual Campus provides access to resources that support the implementation of NES. The ePD and Help Desk in particular are expected to provide the knowledge and skills to support teachers' use of and confidence in implementing the materials. Further, one goal of the NES social networking opportunities is to establish the foundation for NES communities of practice that will support the implementation of NES as well as expand the reach of NES.

The NES recognition structure is designed to drive the use of best practices, both by identifying and making salient what these practices are and by recognizing best practices—including the use of technology and the involvement of family and community—that are exhibited among NES participants at the teacher, student, and school levels.

The use of technology promotes student engagement in the classroom and can provide hands-on problem-solving activities. For instance, research found that in camps designed to increase student interest in STEM, students tended to give more positive feedback on activities involving engineering technology and equipment (Dave et al., 2010) and felt that activities involving robotics technologies held the most value (Nugent, Barker, Grandgenett, & Adamchuk, 2010). Involving the families of students in the classroom is also an important strategy that can be used to encourage student success. Parents play a large role in their children's academic achievement, but rather than directly affecting math or science achievement, parental expectations for their child's engagement in math and science learning, encouragement and shared involvement in math and science activities influence children's self-efficacy in math and science. The more parents signal their belief in the child's ability, the greater the child's own self-efficacy; in turn, higher self-efficacy is associated with higher achievement (Frederick & Eccles, 2002; Bandura et al., 2001; Bleeker and Jacobs, 2004).

1.3.4 Long-Term Outcomes

Finally, a premise underlying the NES project theory is that experiences with NES will lead to outcomes that extend beyond the short-term outcomes described above. As teachers integrate the NES materials into their classrooms year after year and engage in networking opportunities, the reach of the materials is expected to expand to additional teachers and classrooms of students. Increased interest and engagement among students would lead to an increased number of students pursuing additional NASA-related STEM experiences. Familiarity with a wider range of STEM careers and the importance and relevance of NASA missions would lead more students to pursue NASA-related STEM degrees and careers. Even among those individuals who do not pursue STEM careers, their familiarity with NASA and interest in STEM will continue throughout their lifetimes.

As designed, NES will continue to incorporate discovery into the project, and will add new content and increase its offerings. In this way, teachers may incorporate initial NES materials into their

curriculum year after year, and add additional modules that are current and relevant to the content in their classrooms. Further, through NEON an NES/NASA teacher community will develop to support the incorporation of NASA content and materials into STEM classrooms. NES will be incorporated into larger school-wide STEM efforts in schools where NES communities exist within schools. NES will also serve as a gateway for teachers to pursue other NASA opportunities that they are exposed to via the recognition program, the Virtual Campus, social networking, and NES-provided links.

1.3.5 Contextual Factors

The model recognizes that there are contextual factors that may influence the implementation and related outcomes of the project. For example, for the project to work as intended, other factors may need to be in place, such as high-quality and motivated teachers with the ability to understand and teach the materials that NASA offers. In addition, students' ability to grasp the concepts taught may rely on their previous STEM knowledge and experiences in the classroom. Parental involvement, one of the project's best practices because it reinforces student learning and interest in STEM, will not be present in all settings. Additional factors may include the school's technological environment, environment and climate, as well as principal or district leadership, support, and focus on instruction.

2010-2011 Budgetary Effects on NES Inputs and Activities

One important consideration in understanding the implementation of SoI in its first year was the effect that budgetary constraints had on Year 1 inputs and activities. The NES project faced a 30 percent budget reduction during its first full year of operations. This, coupled with ongoing financial uncertainty, forced the project to delay the implementation of key features of the Virtual Campus. Often, NASA headquarters was late in providing dollars and authorization to begin work to the project office due to delays in federal appropriation of dollars.

One component of the NES project negatively affected by this budgetary uncertainty was the recognition program. The teacher and school level recognition efforts comprised a major pillar of the new model, intended to incentive long duration participation and the integration of research - based best practices into teaching practice. However, the opportunities, criteria for participation, and application were not rolled out until the final quarter of the2010-2011 school year, significantly impacting teacher awareness of opportunities and documentation of integration of practices. NES was also forced to delay critical usability testing on the Virtual Campus until the end of the fiscal year, putting the project in a position where improvements to website navigation and user experience changes could not be fully implemented during the first year of operations. Finally, the budget reduction forced the cancellation of numerous activities, including planned alignments of teaching materials to state standards, a teacher and school mini-grant effort to support innovative teaching ideas using NASA materials, and a planned third phase of the Virtual Campus with functionality and data collection capabilities to facilitate school-wide participation and collaboration among classrooms.

2 Methodology

The Year 1 evaluation was designed primarily to investigate whether the NES project is being implemented as intended. To do this, the Abt team focused its attention primarily on measuring the teacher inputs, activities, and outputs set forth in the theory of change, in order to document how a sample of users was implementing NES with their students. Additionally, the evaluation began to investigate some initial teacher short-term outcomes. The Year 2 evaluation will build on and continue this formative work by gathering implementation data through teacher logs that will measure teachers' activities and outputs, and through the systematic collection of teacher and student survey data related to short-term outcomes using a pre-post design.

2.1 Research Questions

The evaluation collected information on participants, implementation, and teacher and student outcomes to answer the following research questions:

Participants

- What are the characteristics of schools, teachers, and students that participate?

Implementation

- What components of NES do teachers access and use?
- How is NES being implemented in schools and classrooms?
- How are teachers supporting their use of NES?
- What are barriers to implementation?
- What are reasons for partial participation?
- What are users' impressions of materials?
- What best practices do teachers use in the areas of: curriculum integration, student engagement, technology use, community outreach, and family involvement?
- Are NES teachers collaborating with one another?

Teacher Outcomes

- What are teachers' comfort and confidence levels with NES products?
- Do teachers' comfort levels with STEM topics change with participation in NES?

Student Outcomes

- What are the levels of student engagement in NES and STEM activities?

2.2 Data Sources

There were two primary sources of data for the evaluation: registration and survey data maintained by NES, and interviews conducted by members of the evaluation team.

2.2.1 Registration Data

As of June 1, 2011, 1,503 individuals had registered for NES.[1] The registration data were combined with the activity reporting database from the Virtual Campus. The activity reporting database contains the number of virtual campus surveys (for specific modules, ePDs, and NASA Now's) completed by all users as well as the number of NES-related activities logged by users with the "My Activities" tool on the Virtual Campus (known as user-generated activities). These surveys and user-generated activities are one indicator of actual use of the NES materials and practices. Exhibit 2 displays the months in which users registered for NES, overall and by whether they had recorded at least one activity on the Virtual Campus. Of the 1,503 registered users, 315 had completed at least one survey of a core activity (curriculum module, NASA Now, or ePD) or entered a user-generated activity on the Virtual Campus. Of these 315 teachers, 144 had completed just a user-generated activity.

Exhibit 2: Registration by Month

	Registered		One or more activity	
	%	N	%	N
September	20.6%	297	40.6%	128
October	18.0	260	22.5	71
November	7.1	102	6.6	21
December	6.3	91	4.7	15
January	10.9	157	8.6	27
February	5.7	82	5.1	16
March	12.4	179	5.7	18
April	9.7	140	3.5	11
May	9.2	133	2.5	8
Total	100	1441	100	315
Missing	--	62	--	0

EXHIBIT READS: 20.6 percent (n=297) of all registered users registered for NES in September; 40.6 percent (n=128) of all users who completed one or more activity registered for NES in September.
Source: NES Registration Database

2.2.2 NES Virtual Campus Survey Data

In addition to obtaining the number of surveys completed by users, NES also provided Abt staff with the raw data from the virtual campus surveys. These surveys were user satisfaction for modules,

[1] Over 1,700 users registered had registered by the end of July 2011, but data for this report are drawn only from individuals who had registered as of June 1 and findings describe these registered users.

ePDs and NASA Nows. Surveys asked users about general ease of use and satisfaction with different aspects of the materials. These user surveys were part of the requirements to qualify for recognition opportunities. Participants became eligible for these recognition opportunities, which frequently included a funded visit to a NASA space center, only after they completed one survey corresponding to each NES component (curriculum module, ePD, and NASA Now). Users completed surveys while logged into the virtual campus and were not told that answers would be anonymous. Exhibit 3 presents the number of completed surveys, the number of users who completed surveys and the average number of surveys completed by each respondent for each of the three NES components. The results of the survey data are included in this report as they correspond to the findings drawn from the interview data described below.

Exhibit 3: Completed Virtual Campus Surveys

NES Component (Number of Products)	**Completed Surveys**	**Surveyed Teachers**	**Surveys Completed Per Teacher**
Content Module	166	102	1.6
ePD	335	140	2.4
Nasa NOW	453	129	3.5

EXHIBIT READS: 166 content surveys were completed; 102 teachers completed content module surveys; On average, teachers who completed a content module survey filled out 1.6 content module surveys.
Source: NES Virtual Campus User Satisfaction Surveys

2.2.3 Interviews with Registered Users

Interviews and conversations with registered NES users served as a primary source of data for the first year evaluation. Conversations were held with teachers who participated in the NES student symposium in the spring of 2011. For the interviews, the evaluation team identified eight different targeted subsamples from the 1,503 registered users based on their patterns of use from the activity reporting database. Ultimately, a ninth group was added to accommodate additional teachers who agreed to participate in the evaluation.[2]

Unique protocols were developed for each subgroup, designed to elicit specific information about NES materials use and implementation. Each protocol emphasized different elements of the NES project, and the set of protocols was designed to together gather an in-depth understanding across the project.

The nine groups were:

[2] Different groups of teachers with nine teachers per group were created in order to follow OMB guidelines, which state that one interview protocol can be piloted with up to nine individuals before clearance is required.

- **Module.** Two groups of teachers (one high school and one middle school) were asked primarily about their use of the NES modules.
- **ePD.** Two groups of teachers (one high school and one middle school) were asked primarily about their use of the electronic professional development.
- **NASA Now.** Two groups of teachers (one high school and one middle school) were asked primarily about their use of the NASA Now video clips and related activities.
- **Non-implementers.** Two groups of teachers (one high school and one middle school) were asked about their reasons for registering for the NES project but not implementing any materials.
- **Communications.**[3] One group of middle school teachers was asked primarily about their use of the various communication and social networking resources available from NES.

A sample of registrants was purposively selected for each of the interview subgroups. Registrants were placed into the high school category if they taught students in grades 9–12, and in middle school if they taught students in grades 4–8. Individuals for each group were then selected from among those users who had completed one or more surveys for the project component about which they would be interviewed. More than 27 middle school teachers agreed to be interviewed for the module, NASA Now, and ePD interviews, and so 6 middle school teachers were available to be interviewed specifically about project communications. Registrants who had not completed any surveys or entered any user-generated activities were identified as non-implementers.[4]

In total, 172 teachers were selected and sent an email invitation to participate in an interview. From among these, 85 teachers agreed to be interviewed, and 66 interviews were completed. Exhibit 4 displays information on the sample of teachers invited to participate, the teachers who were enrolled in the study, and the teachers who were ultimately interviewed.

Exhibit 4: Teacher Response Rates and Sample Composition

	Teachers Invited to Participate		Teachers Enrolled		Teachers Who Were Interviewed	
	N	%	N	% of total invited	N	% of total invited
Module	34	100.0	18	53.0	17	**50.0**
HS	13	100.0	9	69.2	8	61.5
MS	21	100.0	9	42.9	9	42.9
ePD	36	100.0	17	47.2	14	**38.9**

[3] The communications group was created to accommodate additional middle school teachers who agreed to participate in the evaluation.

[4] One user was excluded from selection into this group due to their location and the difficulty of coordinating an interview time across several time zones.

Exhibit 4: Teacher Response Rates and Sample Composition

	Teachers Invited to Participate		Teachers Enrolled		Teachers Who Were Interviewed	
	N	%	N	% of total invited	N	% of total invited
HS	15	100.0	7	46.7	5	33.3
MS	21	100.0	10	47.6	9	42.9
NASA Now	36	100.0	19	52.8	16	**44.4**
HS	15	100.0	9	60.0	7	46.7
MS	21	100.0	10	47.6	9	42.9
Non-Implementer	66	100.0	19	28.8	13	**19.7**
HS	24	100.0	10	41.7	8	33.3
MS	42	100.0	9	21.4	5	11.9
Communications	--	--	12	--	6	--
HS	--	--	--	--	--	--
MS	--	--	12	--	6	--
Total	172	100.0	85	49.4	66	**38.4**
Total HS	67	100.0	35	52.2	28	41.8
Total MS	105	100.0	50	47.6	38	36.2

EXHIBIT READS: Out of 34 teachers invited to participate in the module interview, 53 percent (n=18) were enrolled in the study and 50 percent (n=17) participated in an interview.

Source: NES Registration Data

An additional 20 teachers were interviewed at the NES Student Symposium in May 2011 using a tenth unique protocol. This brought the total sample of interviewed teachers to 86.

It is important to note that because OMB clearance was not obtained during the timeframe of the study, a single protocol was not used to systematically collect information. Instead, data were collected using 10 different protocols, thus not all questions could be asked in a systematic way of the entire study sample.

2.3 Data Analysis

Data analysis consisted of a combination of analyses of NES program data and data collected specifically for the evaluation. Extant data on NES participants were obtained from the NES project registration database, the Virtual Campus activity reporting database, and the virtual campus user satisfaction surveys. This included information gathered on the NES registration form, surveys

collected on the virtual campus, as well as school-level demographics (racial diversity, number of students on free and reduced price lunch, school district, etc.), all compiled by NES staff. The Abt team used this information to calculate simple counts and percentages to describe groups of participants and to summarize virtual campus user satisfaction data.

Interviews were recorded and summarized in writing by each interviewer (after obtaining permission from the interviewee). Once notes were finalized, they were uploaded into an NVivo database for qualitative coding. With the research questions in mind, the Abt team developed sets of codes and subcodes to sort and analyze the interview data to identify trends in the data and answer the study research questions. All qualitative data analyses were completed using NVivo software.

3 Findings

Results of the analyses are presented in the sections below. Information about the characteristics of registered users and their schools was drawn from the NES project databases. Otherwise findings were drawn mainly from analyses of the interview data.

3.1 Characteristics of Participants

Information on the characteristics of teachers and schools participating in the NES project was available in the registration database of NES, and some additional information was provided by interview respondents. As Exhibit 5 displays, registered users are located across the United States, and nine states have over 50 registered users.

Exhibit 5: Number of NES Registrants by State

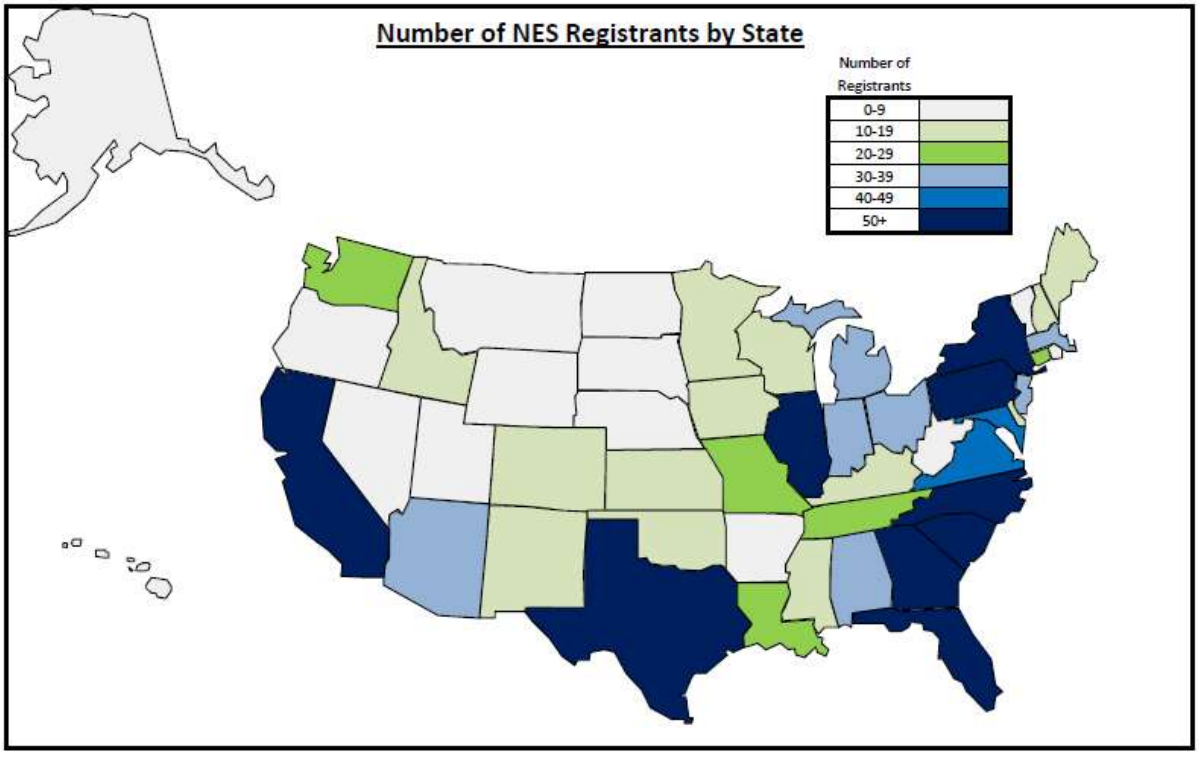

Exhibit 6 shows the characteristics of the NES registered users, the subset of individuals who completed at least one activity, and the sample that was interviewed.

Exhibit 6: NES User and Interviewee Characteristics

	Registered		Completed at Least One Activity		Interviewed	
	%	N	%	N	%	N
Position [a]						
Educator	93.6%	1,407	96.8%	305	91.9%	79
Administrator	7.0	106	4.7	15	8.1	7
Other	1.2	18	1.3	4	4.6	4
Number of NES Teachers per School [b]						
1	74.8%	1,125	72.7%	229	69.8%	60
2	9.2	138	10.5	33	9.3	8
3	5.9	90	7.3	23	8.1	7
4	2.9	44	2.8	9	5.8	5
5+	7.0	106	6.6	21	7.0	6
Subject(s) Taught [c]						
Science	81.3%	1,220	84.8%	267	89.4%	76
Math	43.2	648	38.4	121	34.1	29
Technology	33.3	500	32.7	103	36.5	31
Engineering	18.4	277	19.4	61	27.1	23
Other	22.8	329	25.2	77	22.6	19
Grade [d]						
Elementary (5 and below)	7.8%	117	7.6%	24	7.0%	6
Middle School (6-8)	46.4	698	49.8	157	43.0	37
High School (9-12)	22.1	332	20.6	65	27.9	24
Other	23.7	356	21.9	69	22.1	19
NES Experience [e]						
Historical	13.4%	201	20.0%	63	25.9%	22
Pilot	3.9	59	5.4	17	9.4	8

EXHIBIT READS: 93.6 percent of registered users, 91.1 percent of those who completed at least one activity, and 84.7 percent of those interviewed were teachers.

[a] N=1,501, Missing=2 (Registered Users); N=315, Missing=0 (Completed One Activity); N=85, Missing=1 (Interviewed User). Note: Results do not equal 100 percent because multiple choices were permitted.

[b] N=1,503, Missing=0 (Registered Users); N=315, Missing=0 (Completed One Activity); N=86, Missing=0 (Interviewed User).

[c] For STEM Only: N=1,501, Missing=2 (Registered Users); N=315, Missing=0 (Completed One Activity); N=85, Missing=1 (Interviewed Users). For Other: N=1,441, Missing=62 (Registered Users); N=305, Missing=10 (Completed One Activity); N=84, Missing=2 (Interviewed Users). Note: Results do not equal 100 percent because multiple choices were permitted.

[d] N=1,503, Missing=0 (Registered Users); N=315, Missing=0 (Completed One Activity); N=86, Missing=0 (Interviewed User).

[e] N=1,501, Missing=2 (Registered Users); N=315, Missing=0 (Completed One Activity); N=85, Missing=1 (Interviewed User).

Source: NES Registration Data

Educators comprised the large majority of the registered users (93.6 percent), with fewer administrators (7 percent), or other categories (1.2 percent, e.g., coaches, instructional coordinators, curriculum specialists). Three-quarters of registrants (74.8 percent) were the sole NES registered user at their school; overall, the 1,503 NES registrants represent 1,249 school-level units (1,228 schools, 18 district-level offices, and 3 other types of institutions). Science was the most common subject taught by registrants (81.3 percent), followed by math (43.2 percent). Close to half of registrants (46.4 percent) indicated they worked with middle school grades, while fewer worked with high school (22.1 percent), elementary (7.8 percent) or some combination of these (23.7 percent). Finally, 13.4 percent of registered individuals had participated in the historical NES model, and 3.9 percent were part of the NES pilot program.

The set of teachers who had recorded at least one activity or completed a user satisfaction survey on the Virtual Campus and those interviewed shared background characteristics similar to the overall registrant population, although teachers with previous NES or NASA experience were overrepresented in the interviews. Among the interviewed teachers, 25.9 percent of interviewed teachers reported having experience with the historical NES model, and 9.4 percent were part of the NES pilot program. The interview data shed additional light on interviewees' previous NASA experiences as well. For instance, 42 out of 82 teachers (54 percent) specifically mentioned some type of previous involvement with NASA education programs, and many described longtime use of NASA materials. Thus, while the majority of teachers do not have experience with previous iterations of the NES project, many have experience with NASA education programs in general.

The Abt team also analyzed registration data to learn more about the 1,228 schools in which NES users worked. These data are presented below in Exhibit 7. As these data show, NES users come from schools with diverse characteristics. Schools varied in the proportion of the student body from households below poverty; 36.5 percent of registrants' schools had 0 to 25 percent of the student body living in households below poverty, while 18.1 percent of schools had between 76 and 100 percent of students in such households. Similarly, the student body of 27.6 percent of schools was 0 to 25 percent white students, while 36.2 percent of schools was 76–100 percent. Large proportions of registrants were from schools with 500 or fewer students or between 501 and 1,000 (38.6 and 39.8 percent, respectively). In addition, schools spanned locales from cities (32.7 percent), rural areas (24.4 percent), suburbs (32.6 percent), and towns (10.3 percent).

Information gathered during the interviews provided additional insight into the characteristics of the students of NES teachers and schools. Seventy-eight respondents provided some additional information about their schools, providing evidence of the wide range of settings from which NES draws its users, including high needs or under-resourced, magnet, parochial, private and public schools. Additionally, details provided about the students in their classrooms reflect a broad range of student ability levels (e.g., AP biology, multi-level classes, inclusive classrooms).

Exhibit 7: NES User and Interviewee School Characteristics

	Registered		Completed at Least One Activity		Interviewed	
	%	N	%	N	%	N
Student Body, Percent Poverty [a]						
0 – 25	36.5%	414	32.8%	88	34.6%	28
26 – 50	24.0	272	29.5	79	22.2	18
51 – 75	21.5	244	17.2	46	19.7	16
76 – 100	18.1	205	20.5	55	23.5	19
Student Body, Percent White [b]						
0 – 25	27.6%	317	23.9%	65	32.1%	26
26 – 50	16.1	185	19.1	52	11.1	9
51 – 75	20.1	231	18.4	50	16.0	13
76 – 100	36.2	416	38.6	105	40.7	33
Enrollment [c]						
1 – 500	38.6%	458	37.6%	105	41.0%	34
501 – 1000	39.7	471	41.6	116	32.5	27
1001 – 1500	12.7	150	12.9	36	14.5	12
1501 – 2000	4.1	49	2.9	8	4.8	4
2000+	4.8	57	5.0	14	7.2	6
School Locale [d]						
City	32.7%	392	31.0%	87	35.4%	29
Rural	24.4	292	28.5	80	24.4	20
Suburb	32.6	390	31.0	87	29.3	24
Town	10.3	123	9.6	27	11.0	9

EXHIBIT READS: 36.5 percent (n=414) of registered users, 32.8 percent (n=88) of those who completed at least one activity, and 34.6 percent (n=28) of those interviewed worked at a school where 0–25 percent of the student body received free or reduced price lunch.

[a] N=1,135, Missing=114 (Registered Users); N=268, Missing=21 (Completed One Activity); N=81, Missing=5 (Interviewed User).

[b] N=1,149, Missing=100 (Registered Users); N=272, Missing=17 (Completed One Activity); N=81, Missing=5 (Interviewed User).

[c] N=1,185, Missing=64 (Registered Users); N=279, Missing=10 (Completed One Activity); N=83, Missing=3 (Interviewed User).

[d] N=1,197, Missing=52 (Registered Users); N=281, Missing=8 (Completed One Activity); N=82, Missing=4 (Interviewed User).

Source: NES Registration Data

3.2 Entry into NES

The NES project implemented two new recruitment strategies in Year 1: a peer-to-peer campaign and a greater emphasis on recruitment at professional conferences. Both strategies successfully encouraged teachers and other users to register for the NES project. For instance, the NES project attributes 25.5 percent of its registrations to the peer-to-peer campaign, which provided NES users with access to materials explaining the project, which they could provide to others in an effort to encourage their participation. Additionally, after NES staff refined their conference recruitment pitch, registrations tripled.

In interviews with the Abt team, teachers reported learning about the NES project through a variety of means. In the interviews, 54 teachers provided information about how they initially heard of NES. Participation in the historical NES model was the most common entry point to the current NES project; 16 teachers either taught at schools that participated in the historical NES model or had been aware of the historical model. The second most common way of hearing about the NES project was through a colleague or other professional relationship; ten teachers reported learning about NES from others (e.g., another teacher who forwarded an email about NES, someone in their professional learning network, a parent at their school, etc.). An additional eight teachers reported learning about NES as a result of NASA outreach; specifically, four learned about NES while participating in a workshop or event sponsored or facilitated by NASA, two were introduced to NES through a NASA email or newsletter, one teacher reported having previous experiences with NASA products which led him to NES, and one teacher learned about NES from a personal contact at NASA. Nine participants learned about NES through other organizations; the most common organization mentioned was the National Science Teachers Association (NSTA) (seven teachers), while the others that were mentioned included the Math Science Partnership and the Pennsylvania Math Science Initiative. Finally, a small number of teachers (three) said that they learned about NES through their own Internet searches.

A subset of teachers described their initial interest in registering for the NES project. Of the 22 respondents who provided this information, the most popular reason (13 teachers) was to get new materials or ideas for activities to use with their students. One teacher commented, “The program sounded really good—they told us about the explorations and the hands on activities, that’s really what got me into it—I wanted some new ideas.” Another stated, “I didn’t know what it [NES] was about and I was curious. Whenever I can find science materials out there to reinforce my teaching or have something cool for the kids to grasp hold of some science concepts, I’m all for making sure I have that as part of my repertoire.”

In addition to describing what teachers were seeking from the NES project, these comments also reflect the nature of teachers who are drawn to NES. That is, the teachers who participate in NES are likely to be a self-selected group of individuals who actively seek materials to enhance their STEM teaching.

The second most common reason for registering for NES was previous positive experiences with NASA educational products (seven teachers). For example, one interviewee had previously participated in two distance learning sessions that were sponsored through NASA and received

some distance learning equipment. That work with NASA had been beneficial to the teacher and students in his school as they were able to interact with someone from NASA and had gotten a lot of technology and materials into the school through NASA. He registered for NES because he thought it would provide another avenue for working more with NASA scientists.

Although an important component of NES, the professional development opportunities were not often cited as the hook for teachers. Only two teachers reported being drawn to NES because they were looking for professional development resources.

3.3 Use and Perceptions of NES Components

Information on registrants' use of the materials was available from NES-maintained survey completion data and interviews. Registrants' use of the various NES materials (modules, NASA Now events, and ePDs) as well as information on interviewee's perceptions of the materials are described below.

3.3.1 Patterns of Use and Implementation

NES users are asked to complete user satisfaction surveys related to the various NES components that they use, and these surveys provide some information about use of NES materials. However, registration data coupled with records of completed surveys reveal that the large majority of registrants did not complete surveys. Of the 1,503 registered users, only 315 (21 percent) had completed a survey or entered a user-generated activity as of June 1, 2011, and less than 5 percent had completed one survey for each element of the NES project (i.e., a module survey, a NASA Now survey, and an ePD survey).

Because the interviews were designed to understand the implementation of NES materials, completion of these user surveys was used as the metric to construct subsamples. Therefore, the interviewed registrants had proportionally more NES activities than the larger group of NES registered users.

Among the interview respondents, 77.9 percent had completed at least one survey. Indeed, 41.9 percent had completed at least one survey for each NES project component (module, ePD, and NASA Now); 44.2 percent of interviewees had completed more than three surveys. Exhibit 8 provides the detail on these patterns of survey completion.

Exhibit 8: NES Participants' Patterns of Survey Completion						
Survey Completion	**Registered**		**Completed at Least One Activity**		**Interviewed**	
	%	**N**	**%**	**N**	**%**	**N**
Completed at least one survey or entered one user-generated activity	21.0%	315	100.0%	315	77.9%	67
Completed one survey for each NES project element	4.9	73	23.2%	73	41.9	36
Completed more than 3 surveys	5.0	75	23.8	75	44.2	38
EXHIBIT READS: 21 percent (n=316) of registered users and 77 percent (n=67) of interviewed users completed at least one survey or entered a user-generated activity on the Virtual Campus. *Source: NES Registration Data*						

The interviews provided some insight into the NES participation of the many registrants who do not complete activity forms or surveys on the Virtual Campus. Interviews were conducted with 20 "non-implementers," registrants who did not have an activity recorded in the Virtual Campus. Three of these interviewees held positions that did not put them in direct contact with students (e.g., administrator, instructional coach). Among the other 17 interviewees, 10 of them had, indeed, used NES materials; 6 used NES modules and 4 used NASA Now's. Although limited, this information suggests that individuals who do not complete activity surveys may still be actively using the materials.

3.3.2 Modules

Overall, the majority of registered users (93.8 percent) had not completed any module surveys (Exhibit 9). Just under half of the interviewees (48.8 percent) had not completed any module surveys, although 30.2 percent had completed one module survey, and an additional 21 percent had completed more than one module survey. Unfortunately, it is unclear whether the 94 percent of registrants who did not complete modules surveys are not using the modules with their students or whether they are using modules but not completing surveys. Year 2 evaluation activities are designed to gather information about classroom use, irrespective of whether users complete the associated surveys.

Exhibit 9: NES Participants' Patterns of Use Module Survey Completion

No. of Module Surveys	Registered		Completed at Least One Activity		Interviewed	
	%	N	%	N	%	N
0	93.8%	1410	70.5%	222	48.8%	42
1	3.9	59	18.7	59	30.2	26
2	1.2	18	5.7	18	14.0	12
3	0.7	11	3.5	11	3.5	3
4	0.3	4	1.3	4	3.5	3
5	0.1	1	0.3	1	0.0	0

EXHIBIT READS: 93.8 percent of registered users did not complete a module survey, 70.5 percent of the users who recorded at least one activity did not complete a module survey, and 48.8 percent of the interview sample did not complete a module survey.
Source: NES Registration Data

Among the 86 users interviewed, 55 specifically reported using modules with their students.[5] The most frequently mentioned modules were: Black Hole Math, On the Moon Educator Guides, Rocket Educator Guide: High Powered Paper Rockets, MESSENGER: Cooling with Sunshades, and the Engineering Design Challenge: Water Filtration modules. Among the virtual campus satisfaction surveys, Smart Skies was the most popular module, with 20 surveys completed. Eighteen of the teachers interviewed specifically mentioned that they used the associated ePD prior to implementing the modules with their students. This helped them plan their lesson and make any necessary modifications.

Interviews also provided additional information related to the modules, such as reasons for selection, actual use, modifications, and impressions of the materials, as discussed below. In general teachers looked to NES materials as a means for engaging students with STEM content.

Thirty respondents provided information about why they chose specific NES modules. The most common, reported by 23 teachers, was that the materials fit with their curriculum and standards of learning. Data from the virtual campus user satisfaction survey shows similar results: 97.6% of survey respondents strongly agreed or agreed with the statement "This curriculum support module was a good fit for their classroom" and 95.2% strongly agreed or agreed with "This curriculum support module aligns well with what I teach". Typically teachers were not deciding among multiple modules that fit their curriculum, but were instead identifying the one or few that did and using those. Nineteen of these teachers reported that they integrated the materials into their curriculum,

[5] Four out of the 55 teachers who reported using modules with students specifically mentioned that they only used modules from the historical NES model.

as opposed to the four teachers who used the modules as stand-alone activities (e.g., terminal activities after testing has been completed). For instance, as one teacher noted, when she re-designed her curriculum this year, she considered the various standards from her state and school, and then chose the modules that would fit these standards. Her goal was to "weave space into everything I did." Another teacher explained:

> *I use modules that fit with my curricula. I try to find those that will be the most interesting for my students. My state does have a "same page-same day" policy for the curricula used in the classes but I do find ways to incorporate the NES materials, despite little flexibility.*

This finding suggests that it is important for teachers to be able to find and use materials that easily fit with the topics they are currently teaching their students. Additional reasons cited by teachers for choosing modules included: a desire to introduce students to new topics, scientific approaches, and careers; teachers' own curiosity about the lessons; teachers' experiences with lessons in previous years; convenience (e.g., had hard copies of materials on hand); and, as reported by one teacher, to respond to students' questions about a topic covered in their science class.

It was common for teachers to modify the NES materials for use in their classroom, both for logistical reasons and to tailor the modules to their students' abilities. Specifically, 18 teachers shortened the modules by picking out portions of the modules to use with students, often to work within time restrictions. As one teacher noted, "I had to pick and choose which elements I used. They give you so much material, and it's hard to use everything. I had to cherry-pick."

In addition, 14 teachers reported supplementing the modules with additional resources (e.g., their own materials, technology, books). One respondent stated, "…I modified the activity by using temperature probes…. I modify everything… to make it more appropriate for what I'm trying to teach at the time."

To integrate the modules into their curriculum, nine teachers specifically mentioned that they had to modify the materials. For example, one teacher made modifications based on the requirement that science classes incorporate standards from other disciplines. She fulfilled a writing standard by assigning a persuasive paper on the topic, "Should we still explore space?" Additionally, she used altimeters to measure how far the rockets went, because that was related to a math standard.

In most cases, teachers were using materials that were identified for the grades they taught; only seven teachers specifically noted that they used materials intended for older students with their younger students, while two said the opposite (that they used materials intended for a younger audience with their older students) and three specifically noted that they used the materials with the intended audience.

Even though most teachers were using the modules with the intended grade level, 16 respondents described modifications to the modules intended to simplify the materials. Many of these teachers found the materials too advanced for their students, even though they were using the modules with the grade level for which they were designed. As two teachers commented:

…even though they say its [for] fourth grade, a lot of it is a little [too] high level for my kids. So I modify a lot of it to make it easier for them…. I kind of pick and choose what will work and what will fit into our curriculum.

I did not use all the questions at the end of the module which were suggested by NES to help facilitate discussion. Instead, I chose questions which were appropriate and relevant to my students. Some of the questions were too advanced for [my] students and we hadn't covered the materials in class.

Interview data show that 25 users did not implement modules with their students. Of these 25 teachers, 15 were middle school teachers, 12 were high school teachers, and 3 were elementary (4th grade) school teachers. All 25 were science teachers. Additionally, 6 of the 25 teachers participated in the historical NES model. A common reason for not using the materials was because teachers did not have enough time to review the materials or to implement them properly with their classroom.

Finally, 23 teachers (both implementers and non-implementers) described plans for using the modules in the future, either later in the school year or next year. They felt that they needed time to figure out how to integrate the lesson into their curriculum, integrate technology into the lesson, and modify the materials for different grades and/or ability levels.

Overall, both interviewees and survey respondents had fairly positive perceptions of the NES modules. The vast majority of respondents strongly agreed or agreed with statements about the curriculum modules ease of use, ability to engage students, effectiveness in increasing student interest in STEM, and providing ideas for encouraging student participation (see Exhibit 10). Out of 79 users who expressed an opinion about the modules, 48 participants across all interview samples expressed positive perceptions of the modules during their interviews. Modules specifically mentioned and/or used by these teachers included: Rocket Educator Guide: High Powered Paper Rockets; Black Hole Math; Satellite Meteorology; Engineering Design Challenge: Spacecraft Structures; Engineering Design Challenge: Water Filtration; Engineering Design Challenge: Lunar Plant Growth Chamber; Fingerprints of Life?; On the Moon Educator Guide: On Target; and Smart Skies.[6] Many teachers thought the materials were well-written and useful; 15 teachers specifically said that the modules were written and classified at the appropriate grade level, so that they could easily use them with their students. Thirteen teachers noted that the modules were easy to use and modify, and that they appreciated the directions and background information that came with the materials. Eight teachers liked how the modules gave them new ideas to use in the classroom. For example:

I really liked the inquiry components which captured the interest of my students There was a really strong fit between what I was doing in class, and the structure of the module—students could easily connect the dots between the space station simulation and the water flow on Earth.

I thought the NES modules provide a lot of concepts related to the school's science curricula, and that the teachers could use it as a different way of teaching the curriculum, opening up the

[6] This list only includes modules that were cited at least twice by teachers.

students' imagination. It provides another access point for the ideas, giving them a sense of how things are done, but from another angle.

The Black Hole Math gave me new ideas about presenting [the topic]. I'd always done a little bit about black holes, but I did more this year having had access to the ePD and the module for black hole math…. So it definitely expanded what I was doing. I don't know if it was confidence so much as new ideas, allowing me to do more than I've done before.

Exhibit 10: Curriculum Module User Satisfaction Survey Results (N=166)

Question	Strongly Agree or Agree		Neutral		Strongly Disagree or Disagree	
	%	N	%	N	%	N
This curriculum support module was easy for me to use in my classroom.	95.2%	158	4.8%	8	0.0	0
Using this curriculum support module in my classroom was a good use of my instructional time.	97.0	161	3.0	5	0.0	0
My students found this curriculum support module engaging.	95.8	159	4.2	7	0.0	0
This curriculum support module is effective in increasing my students' interest in STEM topics.	95.2	158	4.8	8	0.0	0
This curriculum support module provided ideas for encouraging student exploration, discussion, and participation.	95.8	159	4.2	7	0.0	0

EXHIBIT READS: 95.2% (N=158) of curriculum module survey responses strongly agreed or agreed with the statement "This curriculum support module was easy for me to use in my classroom"; 4.8% (N=8) were neutral; no respondents strongly disagreed or disagreed.
Source: NES Virtual Campus User Satisfaction Survey: Curriculum Modules

Although respondents were generally positive, some teachers had less favorable impressions of the materials. The most common issue associated with the classroom modules was that the materials were too advanced for students; 11 teachers specifically cited this problem. Two of these interviewees had not implemented modules with their students. Eight were middle school teachers while 3 were high school teachers, and 10 out of the 11 users taught science (although not all taught science exclusively). Modules that were used or mentioned by these teachers included: Black Hole Math (5 out of the 10 thought this was too advanced); On the Moon: Educator Guides; Exploring Space through Math: the Weightless Wonder; MESSENGER: Cooling with Sunshades; Engineering

Design Challenge: Lunar Plant Growth Chamber; Exploring Space through Math: Lunar Rover; Satellite Meteorology; and Smart Skies.[7] As one teacher noted:

> *Black Hole Math, I liked it but [students] couldn't do the work themselves. Bad mark; not because it was a bad module but because it didn't work with my kids. Some of my kids can barely do basic math so that was a little over their heads. On the other hand I think it's good to challenge them. Those that can do it can help the other ones.*

Another common problem was that teachers could not find the content and/or skills they sought. Eight teachers noted this as a specific problem, and the content areas they mentioned were physics, AP biology and chemistry, technology, and pre-algebra. For example, one teacher stated, "modules, [I] haven't used them with the students. I've looked at them and pulled components. None of them fit with my curriculum so I haven't used them." Another teacher commented on the limited selection:

> *Having a wider variety of lessons would be useful. I didn't think that there were that many lessons to choose from—maybe 12 or so. I'm looking for more technology subjects. They had stuff on rockets and stuff like that, but I teach more on computers, more on the technological side of things.*

Other elements of the modules that teachers "disliked" were that the materials did not fit with their curriculum, they lacked access to necessary materials, and that a good deal of preparation and set-up time was required to implement the modules as intended. Specifically, 17 teachers reported experiencing problems due to a lack of resources; this made implementing the materials more difficult. For instance, some said that it was difficult to find and secure the appropriate equipment, while others said that their classrooms did not have access to certain equipment or technology that was necessary to implement a classroom module (e.g., graphing calculators), as illustrated below:

> *The only thing that hasn't gone well—some of the online activities. If I want to integrate, sometimes I might not have those materials or resources. I can access the modules online but I don't always have all the materials (e.g., lab materials, materials necessary to build things) available, so sometimes it's difficult to use in my classroom.*

> *I did look at the Smart Skies module. I will probably use it during summer school, but it is hard to get into computer lab for all of my classes. Maybe on a given day, I can get 3 of my 5 classes into the computer lab, but not for all 5, which makes it hard to plan. Not having computers readily available makes it hard.*

Another issue that surfaced in the interviews (mentioned by six teachers), the lack of NES materials available for students younger than 4th grade, is a direct consequence of the intentional, targeted design of the NES project that focuses on the middle and high school grades. Three of these respondents requested that NES provide materials for younger students, while the other three just indicated that they modified the materials.

[7] This list only includes modules that were cited at least twice by teachers.

3.3.3 NASA Now

Similarly to module use, program data show that the majority of registered users (92.3 percent) had not completed any NASA Now surveys. The pattern also holds for the interview sample, where 45.3 percent of interviewed users had not completed any NASA Now surveys, while 19.8 percent had completed one survey. Exhibit 11 displays these data in more detail.

Interviews provided additional information about teachers' use of NASA Now events. Respondents were asked about their use of the NASA Now events, any modifications they made to the materials, and their impressions of the NASA Now events. Of the 86 individuals interviewed, 65 respondents referred to the NASA Now events; 29 stated that they did not use NASA Now events.

Exhibit 11: NES Participants' Patterns of NASA Now Survey Completion

No. of NASA Now Surveys	Registered		Completed at Least One Activity		Interviewed	
	%	N	%	N	%	N
0	92.3%	1,387	63.2%	199	45.3%	39
1	3.5	52	16.5	52	19.8	17
2	1.2	18	5.7	18	7.0	6
3	0.7	10	3.2	10	5.8	5
4	0.6	9	2.9	9	4.6	4
5	0.3	4	1.3	4	1.1	1
6+	1.5	23	7.3	23	16.3	14

EXHIBIT READS: 91.7 percent of registered users did not complete a NASA Now survey, 63.2 percent of the completed at least one activity group did not complete a NASA Now survey, and 44.7 percent of the interview sample did not complete a NASA Now survey.
Source: NES Registration Data

Similar to the classroom module findings, many teachers (15) chose to use NASA Now events connected to the topics they were covering in their classroom. In total, 11 teachers specifically said that they integrated the NASA Now events into their lessons, 4 reported they used the videos as stand-alone activities, and 4 teachers did both. Respondents' comments illustrate the variety of ways that NASA Now events were used:

> *I watch the NASA Now to see what it's trying to teach and I look at my curriculum to see where it would fit and how it might pull the students in and pique their interest.*

> *I use the NASA Now event to add to the topic the class is covering or reviewing. For example, the class was studying black holes, so the Black Holes event was another way to show students how to gather data from black holes and how to study them.*

> *I use a backwards design, where I work my way backwards from a unit goal to a goal for each day. If, for example, I plan to teach about energy one day, I look at the NASA materials to see if there is anything appropriate to use.*

Virtual campus user satisfaction data supports this finding, as 93.2% of respondents strongly agreed or agreed that "This NASA Now material aligns well with what I teach".

Frequently named NASA Now events included: Black Holes; Extremophiles; and Messenger in Orbit: Propulsion.[8] Robonaut 2 was the most frequently surveyed NASA Now with 32 respondents. Out of the 16 teachers who were asked whether they used any of the related materials, 11 said that they used the pre and post-questions with their students, although the way they used the questions varied: some used them to facilitate small group discussions, some had students respond to the questions individually, and some teachers simply reported using them for opening and/or closing activities.

Because teachers often chose NASA Now events based on topic, many (10) did not strictly adhere to the recommended grade levels associated with the events. Some teachers (four) were not aware that there were recommended grade levels associated with the materials, while others chose to make modifications to either increase or decrease the sophistication of the materials. Specifically, six respondents reported modifying NASA Now content; the most common modification was to change the pre-post questions by reformatting, rewording, or redirecting the curricular focus of the questions.

> *I did have to alter the before and after questions by removing words to make them easier to understand. I would also alter the questions to match the headings on the NASA Now screen to make it easier for my students to understand and follow along. Some questions did not need to be altered because they were basic like "what are different types of energy?"*

> *I use my own questions with the events... at times to have a discussion with the class. [I] pose my own questions, and answer student questions. To go along with the event, I pulled information or found related websites on the NES website, NASA website, or from other sources.*

Others modified the extension activities:

> *As a math teacher, the extension activities don't always fit with what I try to do in the classroom. I have to come up with the math problems that I'm going to do after the NASA Now.*

> *I altered the Robonaut extension activity in order to make it easier for the kids, and I wanted my students to build the materials in a different way.*

Similar to the perception of modules, many teachers had favorable impressions of the NASA Now materials. One teacher stated, "The best thing [about NES] was NASA Now. [They are a] perfect length and get right to the point, yet [they] make it interesting. They always have a little sum-up at end and what's going in the sky-type thing." Overall, 18 teachers from across subsamples said that

[8] NASA Now events included in this list were mentioned three or more times in interview transcripts.

they could not think of anything they did not like or would want to change about the materials. The majority of virtual campus survey respondents strongly agreed or agreed that they could apply what they learned in the NASA Now and that it provided ideas for encouraging student participation (see Exhibit 12).

Exhibit 12: NASA Now User Satisfaction Survey Results (N=452)

Question	Strongly Agree or Agree		Neutral		Strongly Disagree or Disagree	
	%	N	%	N	%	N
I can immediately apply what I learned from this NASA Now material to my teaching about STEM.	95.4%	432	4.0%	18	0.4%	2
This NASA Now material provided ideas for encouraging student exploration, discussion, and participation.	97.4	441	2.0	9	0.4	2

EXHIBIT READS: 95.4% (N=432) of NASA Now survey responses strongly agreed or agreed with the statement "I can immediately apply what I learned from this NASA Now material to my teaching about STEM"; 4.0% (N=18) were neutral; 0.4% (N=2) strongly disagreed or disagreed.
Source: NES Virtual Campus User Satisfaction Survey: NASA Now

Some respondents highlighted particular aspects of the NASA Now events that they liked. Fifteen teachers specifically noted that they liked the length of the NASA Now events. For example, one user responded, "I did like those. They were short enough that they didn't lose the kids' interest but yet it gave them a lot of information. And they weren't really way over their heads, which was good."

Five mentioned that they appreciated the increased exposure to STEM careers that the events provided, and 12 teachers described experiencing increased student engagement and/or improvements in student behavior as a result of the NASA Now events. For example, one teacher stated, "I love the NASA Now videos. The people in the videos are very exciting and the students connect with them and really enjoy the videos." Similarly, 92.3% of virtual campus survey respondents strongly agreed or agreed that the NASA Now increased students' interest in STEM careers and 96.3% strongly agreed or agreed that it increased students' interest in STEM topics.

Respondents raised some challenges they had encountered. The most common problems experienced by teachers were related to technology. Eight teachers reported difficulty interfacing with the NASA Now events; some had trouble using the website and the search functions, while others had problems with their own technology. For instance:

> *Technology has not gone well, but it's never a NASA problem, it's a problem with the school. Sometimes the Internet would be down. That's the only thing that's gone wrong. One day I will have a plan to show a NASA Now, but then the Internet in the school would be down. I would*

love to be able to access an archive of NASA Now's so I can download them and keep them on file.

I… tried to use NASA Now, but when I tried to pull down the latest videos, I kept getting the first one again.

The second most common issue concerned the target audience of the NASA Now materials. Six teachers, most of whom were high school teachers, described the NASA Now events as being "geared toward middle school students" and felt that the NASA Now events were "over the top" stylistically (in terms of hosts, music, animation, etc.). As one teacher noted:

The NASA Now's have great content and presenters. But… the music is a little cheesy for my high school students. Students tune out before they watch…. I would like to see the videos be a little more professional without making them elementary.

Additionally, a few teachers remarked that the time-sensitive aspects of the NASA Now materials (e.g., the extension activities) were not useful. Given the preference of choosing NASA Now events based on the ability to integrate the material into the curriculum, teachers did not always view the events at the time they were initially launched, and therefore could not always participate in related events (e.g., enter a contest, write in with a question) in a timely fashion. Three users felt the deadlines of related activities made the archived NASA Now materials seem unnecessarily dated. For example,

…at the end of the event, where they talk about upcoming events, that just shows students that the event is dated. I would cut that part off so it doesn't make the NASA Now event seem like old news."

The timing issue is the drawback though—I'll play one and then it says "coming up next week," and I have to say "not for you guys," or "we already saw that one" because I have to do them in my order.

3.3.4 ePD

The data on ePD use, as measured by survey completion, again indicate that a small percentage of registered users are completing multiple ePDs, while many NES users are either not using the ePD resources, or are not completing the surveys associated with each ePD session that they view (see Exhibit 13 below).

Exhibit 13: NES Participants' Patterns of ePD Survey Completion

No. of ePD Surveys	Registered		Completed at Least One Activity		Interviewed	
	%	N	%	N	%	N
0	91.7%	1378	60.3%	190	41.9%	36
1	3.9	59	18.7	59	23.3	20
2	1.8	27	8.6	27	10.5	9

Exhibit 13: NES Participants' Patterns of ePD Survey Completion

No. of ePD Surveys	Registered		Completed at Least One Activity		Interviewed	
	%	N	%	N	%	N
3	1.0	15	4.8	15	9.3	8
4	0.5	7	2.2	7	4.6	4
5	0.3	4	1.3	4	2.3	2
6+	0.9	13	4.1	13	8.1	7

EXHIBIT READS: 91.7 (n=1,378) percent of registered users did not complete an ePD survey, 60.3 percent (n=190) of the group that completed at least one activity did not complete an ePD survey, and 41.9 (n=36) percent of the interview sample did not complete an ePD survey.
Source: NES Registration Data

In total, 65 respondents discussed the NES ePDs during their interviews. The Abt team asked these teachers about their use of the ePDs, as well as their impressions of the materials (e.g., perceived usefulness, likes and dislikes).

More teachers reported using live ePDs (15) than the on-demand ePDs (7). Seven teachers indicated that they used both live and on-demand options.

Teachers commonly used the modules associated with the ePDs they viewed (25 teachers). Of the nine teachers who specifically reported not viewing ePDs, three teachers said that they implemented modules with their students.

Although ePDs are designed for teachers and the NES materials contain videos that can be used with students, seven teachers reported showing ePD resources to their students because the materials presented ideas clearly, they gave students a visual of what they would be doing in class, and the ePDs helped to boost students' confidence by showing them that other students could complete the activities.

Virtual campus user satisfaction surveys show that users were generally satisfied with the ePD's (see table 14). In interviews with the Abt team, more than half of the teachers (38) indicated that the ePDs were useful resources.

Exhibit 14: ePD User Satisfaction Survey Results (N=335)						
Question	**Strongly Agree or Agree**		**Neutral**		**Strongly Disagree or Disagree**	
	%	**N**	**%**	**N**	**%**	**N**
After participating in this ePD activity, I feel confident in using the associated NASA curriculum support module in my classroom.	94.6%	317	3.9%	13	1.5%	5
After participating in this ePD activity, I will be more effective in teaching STEM concepts introduced in this associated NASA curriculum support module.	95.5	320	4.2	140	.3	1
I can immediately apply what I learned from this ePD to my teaching about STEM.	94.0	315	3.9	13	2.1	7
This ePD activity has helped me to understand how I can use the associated curriculum support module in my classroom.	96.4	323	2.4	8	1.2	4
After participating in this ePD activity, I am more likely to use the associated curriculum support module in my classroom than had I not participated in the ePD.	94.0	315	4.2	14	1.8	6
This ePD activity was sufficient support to allow me to use the associated support module in my classroom.	94.33	316	4.2	14	1.5	5
EXHIBIT READS: 94.6 % (N=317) of ePD survey responses strongly agreed or agreed with the statement "After participating in this ePD activity, I feel confident in using the associated NASA curriculum support module in my classroom"; 3.9% (N=13) were neutral; 1.5% (N=5) strongly disagreed or disagreed. *Source: NES Virtual Campus User Satisfaction Survey: ePD*						

Twenty-nine teachers reported that the ePDs provided good information on how to implement the materials with their students and the types of instructional strategies to use:

> *Seeing the materials being used has increased my confidence in using the materials, [but] not necessarily [with] the content. Seeing it being done gives me ideas for instruction, and for how to use the materials to inspire students.*

Some also reported that the ePDs were useful for figuring out how to modify the materials:

I learned another way to do a rocket experiment besides using a small solid fuel engine. The new way is less risky, which is good, because safety is important, especially with students. The NASA training didn't go into enough scientific detail that I didn't already know, but it showed me some pedagogy that would work.

Sixteen teachers indicated that the ePD provided them with useful information on the actual content of the module, thereby enhancing their own knowledge base.

The black hole math [ePD] was the most helpful one because it went into a lot of detail about black holes, not just about the math in the packet. I liked the information they provide. I wanted more.

My students and I all went into the design challenge without a lot of background knowledge. I worked with the students, sometimes not completely knowing the answers, but having that background knowledge from the ePDs helped.

Other elements of the ePDs that teachers liked included: the interactive nature of the live ePDs and the ability to get instantaneous feedback from both colleagues and experts; the convenience of the on-demand ePDs; the fact that ePDs were easy to share and were designed to be viewed in segments; and the fact that they were convenient (i.e., they could complete the trainings at home on their own time).

Respondent teachers also provided some criticism of the ePDs. The most common problem with ePDs was timing, as indicated by 11 teachers. For some teachers, especially those on the west coast, the ePDs were held at inconvenient times which made it difficult for them to participate in the live sessions:

Many of the ePDs I wanted to take early in the year were only available at times I couldn't participate (I'm in the Pacific Time Zone). School finishes at 3:00, I leave school at 3:30 and get home at 4:00. Many of the live ePD times will NOT fit with that schedule. If you can't get an ePD until January or February, it gets a little useless if you wanted to use it much earlier.

In K-5, we cover certain topics at certain times. I may be involved in a great ePD, but the topic doesn't come up for a couple of months in my curriculum. Maybe you get great ideas or are given good links to information from the ePD, but by the time the topic comes up in class, you don't remember them.

Other teachers felt that the ePDs were too long, or that they were scheduled for the wrong time of year:

Frankly, we don't have 45 minutes to do a 20 minute presentation. Trying to make it so thorough, took so much time. Teachers know how to do most things, they just need to see how the thing works and they can figure out the details. If they can't, they probably shouldn't be a teacher.

The next most common problem related to the technology associated with the ePDs. Six teachers reported encountering technological problems that either prevented them from fully participating in

ePDs, or made it impossible for them to participate at all. Some of these problems included not being able to find links, links not working once they were found, videos that did not stream properly, computers that crashed during live events, etc.

> *When I downloaded it, I only got a certain amount of material. In the presentation, the instructor had a lot more material including datasets that I could not find. I attempted to contact the instructor to ask about that but did not get a resolution.*

> *The videos are problematic sometimes. I'm pretty sure we can download them but they don't seem to play as nicely as they should. They are choppy, even when you aren't streaming it online. Has NES thought about having them on iTunes to download? Maybe that format would be different.*

3.4 Virtual Campus

Sixty-seven of the 86 users interviewed provided information about their impressions of the NES Virtual Campus. These respondents were asked about the usability of the site (e.g., if the site was easy or difficult to navigate, their impressions about the amount of information on the Virtual Campus). Overall, more users who commented on the Virtual Campus felt that it was easy to use and navigate than not.

Specifically, 36 respondents indicated that the Virtual Campus was easy to use and/or that they liked the website. Some specific elements of the Virtual Campus that these teachers liked included the left-hand navigation panel, the calendar, the Help Desk, and the search function. Others commented that they were "impressed with the fact that so much information was available," that the "NES site is easier to use than the overall NASA site," and that the new Virtual Campus is "an improvement over the old website." Six additional teachers reported that while they thought the Virtual Campus was difficult to use at first, it became easier. Additionally, 11 teachers reported that they had not had a chance to explore the Virtual Campus, and therefore couldn't comment on the site's usability.

In contrast, 26 teachers reported feeling that the Virtual Campus was difficult to use. Some of these teachers had experienced a specific technical difficulty, while others just felt that the Virtual Campus was not a user-friendly site in general. For instance, one teacher noted that:

> *NES needs to change to make it a resource you want to go to first, before the NASA site. Otherwise, you can just go to the NASA site and there is enough there to keep you busy forever. Right now, NES is just another level of searching, just a secondary thing. NES needs to be more user friendly for the average teacher.*

Of the 26 teachers that reported a negative impression of the Virtual Campus, 15 felt that the site was difficult to navigate. Specifically, many said that they had problems either searching for materials or with returning to materials that they had previously found. For instance, one teacher commented:

> *It's difficult to return to a* NASA Now *that I have previewed. I know that there is a search engine for it but if I don't remember the exact name of the* NASA Now*, it seems that it can take a while*

> *to get back. I suspect there is a way to create a* "my *content*" *library but I haven't had time to explore or do that yet…. I couldn't navigate back to the extended series on Black Holes if I had to—it's a wonderfully produced material but I had to spend an hour and a half finding it again after I found it the first time.*

Additionally, eight teachers reported experiencing some types of technical problems, while four teachers felt that the level of information on the Virtual Campus was overwhelming. For instance, one teacher noted that "there is so much when you open it… for older teachers, it is overwhelming and discouraging. Teachers don't have a lot of time so we give up." Teachers also complained that it was sometimes difficult to share materials with colleagues, and some (six teachers) wished that students could have access to the NES Virtual Campus as well. Three teachers reported that they wished they could download materials, which is actually a function of the NES Virtual Campus, however it is important to note that two of these respondents were non-implementers.

3.5 Communication

There are numerous methods of communication and collaboration available to NES project users. Eighty-one respondents commented on NES communication efforts during their interviews. These respondents discussed their impressions of NES communications as a whole (in terms of responsiveness, helpfulness, etc.), as well as the specific communication tools used by NES (orientation, eBlasts, NEON, and social networking tools).

Feedback on overall communication and responsiveness from NES staff was mainly positive. Specifically, out of 20 people who commented on the responsiveness of NES staff in direct communications, 15 noted that they were very responsive, while only 3 reported some type of breakdown in communications. Teachers reported appreciating the personal nature of emails from NES (e.g., communications which demonstrate an awareness of how that teacher is using the program and which make appropriate suggestions for additional implementation), and some respondents reported that these types of emails prompted them to join NEON or apply for recognition opportunities. For instance, one interviewee said:

> *I got some personal emails when they noticed that I wasn't using it the way that I wanted to. I got weekly, or bi-weekly emails. I couldn't ask for more. They communicated to me better than other organizations I belong to.*

Almost all respondents approved of the general frequency of communication, and some indicated regret at not having enough time to engage in communication with NES; only one thought that the frequency of communication was too great. However, some teachers found the NES encouragement to log activities excessive. One teacher commented:

> *With NES I get emails from various people who are involved with it, I believe that there is a place to log activities. I started to do that, then I received further emails about those particular posts. These emails asked me to post more and elaborate on what I was doing and create more reports. It felt like someone was giving me an assignment on what to do next. I have enough to do with responsibilities to my students and school…. It's an intrusion on my time. One of the emails I received wasn't even stated politely.*

Another teacher noted that the nature of the communications with NES was "very persistent." Nonetheless, he followed through with his recognition opportunity application, even though he was busy with other things, and he was chosen to participate in a teacher opportunity.

Overall, teachers seemed to prefer some communication tools over others. Findings suggest that while some of the tools serve a specific purpose and provide unique value to the teachers, others do not. Specifically, the orientation sessions were valuable to users because they helped make users aware of the various NES components and how to navigate across the components. In addition, the eBlasts and NEON were reported to provide unique information and serve a distinct purpose for the teachers. However teachers do not appear to ascribe a unique value to the other social networking tools. Feedback on the individual communication tools is discussed below.

3.5.1 Orientation and Help Desk

Data show that orientation was, in general, well-received, and that teachers believed it provided them with useful information. As one teacher stated, "The orientation was great—found it really useful when I think that most orientations are bland and not helpful. Like the staff—they provide a lot of information and make it really easy to use." However, a few teachers were more critical. For example, one respondent stated, "It just seemed like the webinar (orientation) was rushed—there is so much information to get through but not really the time to digest the information I was given. I know the stuff is available online."

Of those teachers who discussed orientation in their interviews (24), only 7 indicated that they did not attend an orientation. Of these seven teachers, five were non-implementers.

Experiences with the Help Desk were mixed. Of the seven teachers who discussed their experiences using the Help Desk to address technical problems, two did not find the Help Desk to be useful; one teacher could not get through using the number he/she had, and one found the number too late, and therefore the information received was no longer useful. On the other hand, five teachers reported benefitting from the Help Desk.

3.5.2 eBlasts

Most respondents who commented on the eBlasts had favorable impressions of these communications. Specifically, 33 teachers reported liking the eBlasts, noting that they were a good reminder to stay engaged with the NES project and that they were a good source of ideas for new materials to try or activities to complete. Only three respondents reported having an unfavorable view of the eBlast; their chief complaint was that they did not like opening a PDF to access the eBlast content, and they would prefer to have the information in the body of the email. For instance, one teacher said:

> *I'm a little confused on the format of e-blast—earlier the content was in the body of the email and it's now a PDF. PDF's are problematic because my computer is old, and there is a finite amount of storage. If I don't delete my eBlast, other messages will get blocked out.*

On the other hand, 15 teachers said that they did not read the eBlast at all (or not as much as they would have liked), primarily due to time restrictions. For instance, one teacher noted that she reads

between one-third and one-half of the eBlasts, but that when she does have time to read the newsletter, she finds good information in it. As another teacher noted:

> *I have been getting all of the eBlasts. I read the e-blast sometimes but right now in the state of New York, they are doing standardized testing. Sometimes I delete them or save them for another time. The eBlasts are useful when the topic is something I am currently covering in class, but that isn't always the case.*

There were no comments explicitly addressing an uptick in eBlast communication in spring 2011, although a few teachers were aware that eBlasts were sent every Wednesday afternoon.

3.5.3 NEON

While NEON was the most frequently used collaboration tool (as opposed to the other social networking tools found on the NES site), teachers' impressions of and experience with NEON were divided. More teachers said that they did not use NEON (22) than those who did report using the tool (16). Of those teachers that did use NEON, only seven teachers reported actively engaging with other NES users through the site, while the other half reported reading, but not posting content. Each of the 16 teachers who reported using NEON said that they wanted to see what other teachers were doing, and get ideas for their own use of NES materials. For instance, one teacher discussed how she joined a Skype learning group that was organized through the NEON science group. This group meets weekly to discuss how to incorporate Skype into the educational curriculum. This teacher noted, "It's nice for teachers like me that are learning how to use that technology to interact with teachers who have used that technology."

Twenty-two teachers reported not using NEON. The reasons they cited for not using this tool included time constraints, difficulty using the actual site (e.g., problems with logging on and choosing a group), and lack of understanding about the purpose of NEON. For instance, one teacher stated, "I was able to log in [to the NEON site] but I had trouble selecting a group. It might be useful to have some information explaining how to do that."

3.5.4 Other Social Networking Tools

Finally, teachers discussed the perceived value of the various NES social networking tools (including the Teachers Corner Blog, Twitter, and Facebook). About one-third of teachers who commented on these tools reported using at least one of these social networking tools. Facebook was the most frequently used tool; 12 teachers reporting being "friends" with NES. Respondents mentioned using Facebook to receive updates, but did not mention using it to collaborate with others. Teachers found the Facebook posts valuable:

> *I get posts on Facebook from NES…. I'm not on that often but I do see the updates. It can be kind of a bummer—you see something asking for the first 20 people and I email them thinking I made it into the first 20 and then they email me back saying that they have everyone. It's good because it offers extra opportunities, but I don't always see them and I don't get to take advantage of them. If anything it lets me know that there is new content available—that's what I use it for. I'd have to get alerts or check it often to know about some things and I can't do this when I'm teaching.*

Additionally, five teachers reported following NES on Twitter, and three reported using the Teachers' Corner Blog. For instance, one teacher noted that she prefers to use Twitter, because it is quick and gets right to the point. Another teacher noted:

> *I read it [the Teacher's Corner Blog] once or twice a week—I like the helpful hints and suggestions from other teachers on how to do different things and about what worked and didn't work. I also like the current events.*

Reasons for not using other social networking tools (Facebook, Twitter, and the Teachers' Corner Blog) again included a lack of time and technical skills:

> *I don't use the Teacher's Corner. I don't blog. I don't plan to use it—I've got more on my plate for the blogs that I'm supposed to do already, that I don't need another one. There are certain ones I have to do for school. It's nice to know that I have some place to ask questions if I need to.*

Another significant barrier was the fact that schools often block social networking sites from their computers. For instance, one teacher who used Twitter noted that she can access Twitter at her school, but Facebook is blocked. Additionally, some teachers were unaware of the various tools; one teacher reported that he did not realize there was a NES Facebook page.

3.6 Recognition Opportunities

Of the 86 teachers interviewed by the Abt team, 67 provided some type of information about their knowledge of recognition opportunities and/or whether the recognition opportunities motivated participation in the NES project. Twenty-eight teachers stated that they were chosen to participate in a teacher recognition opportunity in 2011.

The majority (57) of these 67 teachers who mentioned the recognition opportunities indicated that they were aware of at least one type of recognition opportunity (e.g., student, teacher, or school). The 10 who were not aware of the recognition opportunities were mostly interviewees in the non-implementer group.

Teachers were split on whether the recognition opportunities provided motivation to complete NES activities and/or surveys.[9] Eighteen teachers indicated that they did serve as a motivator, while 20 said that they did not. Some respondents specifically reported that they participated in activities because of the recognition opportunities; for instance, one teacher reported completing an ePD and the associated module during the school year, rather than over the summer, "for the recognition opportunity, not to learn how to use a module." On the other hand, many of the teachers who said that the recognition opportunities did not motivate them said that they would have used the materials regardless of the opportunities. For instance, one teacher said:

[9] The question asked teachers to indicate whether recognition opportunities served as a motivator to complete activities or surveys. Therefore, it is not possible to conclude whether they served as a motivator for teachers to use activities but not to complete surveys, or vice versa.

> *I wouldn't say that it [the recognition opportunity] motivated me. It was a minor motivator to know this opportunity was there but I would have used the NES content whether or not there were recognition opportunities. Completing a survey once in a while isn't bad—if that meant that I got to go and participate it was an extra bonus. I was going to use the NES materials no matter what.*

Additionally, a few teachers specifically indicated that they did not want to be recognized, and therefore the opportunities did not motivate them to participate in NES.

Overall, teachers had positive impressions of the recognition programs, and there were very few recommendations for improvement. One recommendation, from a teacher who was involved in the historical model, was to provide information about criteria for the recognition opportunities to teachers earlier:

> *Initially we weren't sure how to apply or how to qualify for the different opportunities. So more information sooner would be good. We didn't know what the criteria for the opportunities would be and if they changed with the new model. If the criteria changes they should let participants know as early as possible.*

Some users reported barriers that had prevented their participation in various recognition opportunities. Specifically, 12 teachers discussed problems with the application process for the recognition opportunities. For instance, 11 teachers felt that they did not have enough time to apply or complete the surveys, for example:

> *I don't have time to complete the surveys at school, and the recognition opportunities are not sufficient to motivate me to stay at school to complete them. Completing them at home is a challenge.*

Four users did not fully understand the requirements or the application process:

> *I thought the recognition opportunity program was very confusing, with all the requirements. I tried to contact people but couldn't figure it out for this year. They said I could try to apply again next year. I just didn't know how to do it this year, and I'm still not clear on how to do it. I have so many things going on. I hope that someone can remind me and help me figure it out for next year.*

Additionally, two teachers said that they experienced problems with saving their application information, and one teacher was forced to re-do an entire application. One teacher explained, "I was getting an email about those opportunities. They would tell me that I had to fill out just one more survey to qualify, but it was in the middle of lacrosse season, so I didn't follow up."

Several teachers (seven) did not apply because they felt their activities did not warrant participation in the recognition activities, that is, they felt they had not done enough to be recognized. As one teacher noted:

> *I didn't apply. I didn't feel that I learned anything, that I haven't used it enough to earn an award. If I did, I would have thought about applying, but I'm sure that there are plenty of people*

far more deserving than I am for using NES in a more effective way, or more often, than I did. Maybe pursue next year. I'd like to do some of the things that NES offers, but didn't feel it was appropriate this year.

Six teachers reported that their schedule would prevent them from participating in a teacher recognition opportunity. Additionally, six teachers noted that while they were interested in pursuing a school recognition opportunities, they could not qualify because they were either (a) the only NES teacher at their school or (b) they could not convince their colleagues to use the materials and/or complete surveys. And finally, five did say that they planned to pursue recognition opportunities in the 2011-2012 school year.

3.7 Best Practices

NES staff and partners identified a host of best practices for educators to use, and these are included as part of the criteria for the recognition opportunities; these best practices are also among the stated short-term teacher outcomes of NES. Among these practices are using technology, facilitating collaboration (both among students and with colleagues), and involving both family and community members in the NES activities.

Many more respondents indicated that they used technology when implementing the NES materials (33 teachers) than did not (7 teachers). However, teachers had varying ideas of what "technology" was. Overall, the most popular technologies cited by teachers were Smart Boards/Promethium Boards (11), computers/Internet (10), videos (7), PowerPoint/Excel (6), and cameras (5). Two examples provided by teachers demonstrate the varied levels of technology use:

[We] have the Lab-Quest sensor program and have used Forceplate to measure the force that the eggs drop with. [We] use computers to project images and cameras to document activities.

[I] have a Smartboard and projector in the classroom. There is only one other computer in classroom. [We] do not have a lot of technology. The events and activities haven't been very technologically exclusive. [I] would use the projector to show the activity, but that's it.

Many users (16) said that their use of technology associated with the NES materials and activities promoted student collaboration, while only 4 teachers specifically said that they did not use technology for this purpose. An important note is that teachers discussed their efforts to promote student collaboration both in relation to the NES materials and more generally. Of those respondents who said that technology increased student collaboration, eight said that the collaboration occurred between students within the classroom, two said that they collaborated with other students in their school, and two said that they used technology to collaborate with students in different locations. One interviewee explained:

We're working with other schools and sharing rocket designs by posting on Google Docs, using Skype and Bridget to collaborate. We love using technology. The kids have found a variety of things at NASA—using a NASA applet that they found. We have a one-to-one student to computer ratio.

Technology also supported teacher collaboration around NES; 30 respondents reported engaging in networking with other NES teachers. The most commonly cited forms of networking included using NEON (14), using the Teachers' Corner blog (6), collaborating with other teachers in the school (5), and collaborating with other users via live ePD (5). Other teachers used social networking tools to collaborate and build relationships with colleagues they met at professional conferences. For example, through the Skype learning group of NEON, one teacher described support in learning how to incorporate Skype into her curriculum.

Finally, many NES users provided information on the extent to which they involve family and community members in their NES activities. Regarding family involvement, 19 respondents said that they were not able to involve families in either NES activities, or in more general STEM activities at their school. Many of these interviewees indicated that they would like to improve this next year.

> *I wasn't able to [involve families or community members] this year. I'm trying to think of ways I can get in contact. We're located near [university] which does work with NASA so I'm going to try and get in touch with people there, people in the city. Get more people involved. I couldn't do that this year.*

On the other hand, 15 respondents did include families in their STEM activities at school, although it was not always clear that they were involving families in NES activities. Some examples of ways they involved family members included inviting them to school-wide NASA nights, involving them in end-of-unit culminating events (such as rocket launches or robotics competitions), and asking parents to teach science lessons. One teacher described inviting parents who are engineers or contractors for NASA to a "Career Connections" lesson to discuss their careers. Another involved the PTA to help support classroom activities. "[The] PTA was very helpful in collecting donations for the supplies students would need to construct their lunar chambers, and they also helped fund the building of some of the rockets."

A similar pattern was evident with community involvement. Specifically, 18 teachers said that they did not attempt to solicit any community involvement, while 13 did (again, many did not specify this involved NES-specific activities; rather, they discussed how they involved the community in STEM activities at their school). Some examples included collaborations with local universities, school presentations, and community involvement in science fairs or school NASA nights. One teacher brought in a professor from a local university for a culminating unit activity. Another respondent described community recognition of students' involvement in NASA events:

> *The three girls who went to the shuttle launch were honored by the county as heroes and good role models for their peers…. The students write reflections when they go on trips that are printed in the local paper.*

3.8 Outcomes

3.8.1 Teacher Outcomes

During the interviews, NES teachers were asked to discuss outcomes associated with their use of the project materials. Specifically, the Abt team asked teachers whether their confidence with both

STEM content and the NES materials had changed due to their participation in the program, and whether they were more or less likely to use NES and NASA education materials in the future. Some teachers also provided information on how their teaching practices have changed as a result of their participation in NES. Exhibit 15 details these findings by showing the percentage and number of teachers who reported various teacher outcomes related to their participation in NES. We analyzed the data to determine whether or not teachers who participated in the historical NES model were more or less confident with STEM content after participating in the project, and there were no notable differences between the historical and new NES teachers.

Exhibit 15: Changes in Teacher Practice and Confidence

Teacher Outcomes	Current Model [a]	
	% of Sources	N
Teacher Practice	29.1%	25
Inquiry-based Learning	7.0	6
Integrating Math and Science	4.7	4
Hands-on	8.1	7
Confidence with STEM	44.2	38
No Effect	8.2	7
Confidence and Comfort with Materials	30.2	26

EXHIBIT READS: 29.1 percent of teachers described changes in teacher practices related to their use of NES.
[a] N=86
Source: NES User Interview Data

In total, 81 out of the 86 interviewed users provided some type of information on outcomes related to use of NES materials. Eleven of these were individuals who had not yet used the materials in their classrooms, but based on their review of the NES materials, planned to in the future. Of these 81 teachers, 38 reported that they were more confident with STEM content after using the NES materials. Many of these teachers expressed increased confidence with a scientific discipline apart from their own due to participation in NES:

> *My degree was in biology so I've studied science and feel more confident there. [I have] been building the math portion of STEM as well. So the Cooling with Sunshades helped bulk up my engineering portion. We had to really talk about what engineers do when they build things involving heat. It helped me and the students as well.*

> *It helped provide me with the technical background to implement the modules with my students. Teachers have technical background in science, physics, chemistry—but not necessarily in the topics that they're choosing. It gives the vocabulary I need and the ability to access it.*

Only six teachers reported no change in their confidence levels.

Confidence in using the NES materials also increased; 26 teachers specifically reported that they felt increasingly confident using NES and/or NASA educational materials after participating in the program. For instance, one first-year NES teacher who reported increased confidence with the materials, said that he implemented a module in two different classes, and the second time he used it, "I was able to use it [the module]" more smoothly. There was no significant change in confidence levels between historical and current-model teachers.

Twenty-six teachers said that participating in the NES project led to changes in their teaching practice. Again, there was no significant difference between historical users and current-model users in this outcome. Of these 26 teachers, 7 noted that they now incorporated more hands-on activities into their teaching; 6 said that that they tried to integrate more inquiry-or project-based learning into their curriculum, and 4 said that they made a greater effort to integrate math and science instruction after using the NES materials:

> *In the classroom, I incorporate more engineering into regular core classes, and use more hands-on activities (like making/building things).*
>
> *I've taught up through Algebra 2. The integration of math into science content is really helpful. As predominately a math teacher, I would not think of to investigate. It might not occur to me to go to the moon to talk about cooling and angles. NES has helped me to include the engineering piece now.*

Another teacher noted that NES led him to other NASA opportunities for teachers that have altered the way he teaches. He explained, "The NES program led me to apply for NASA's Project-based inquiry learning course. This course has truly transformed the way that I plan, teach, use the state standards, and assess students. Even in math now I'm teaching science."

Only two teachers specifically reported that using NES materials had no impact on their teaching practice.

Finally, many teachers (49) indicated that they were likely to use NES or other NASA educational resources in the future. This reinforces the positive perceptions that many users have of the NES materials. For instance, one teacher noted that "NASA is a trusted source… that provides information I can rely on." Another user noted that his familiarity with NASA products has "gone up exponentially" and that after using the NES site, he knows where to get useful NASA materials. He reports that he now has access to an "enormous universe of stuff."

3.8.2 Student Outcomes

Respondents also discussed their perceptions about students' experiences with the NES materials, and whether there were student outcomes related to participation. Sixty-four teachers discussed their perceptions of NES-related student outcomes. Overall, teachers believed that students' experiences with NES materials, both content modules and NASA Now videos, were positive. Teachers commented on students' engagement with NES materials and STEM content, students' comprehension of STEM content, and their interest in STEM-related to careers after participating in NES.

Fifty-four teachers reported that the NES materials used in class contributed to improved student engagement with STEM materials. No one specifically reported negative or no changes in student engagement after using the materials. As examples of student engagement, many teachers reported that their students engaged in more conversation and questioning, that they requested to do the NES activities in class, and that there were reductions in discipline problems when using the NES materials. Teachers reported that the most engaging aspects of the materials were the opportunities to engage in hands-on activities and to see the real-world application of STEM content that students were learning in school:

> *A few of the lower end students get lost, but it gives them an overall greater appreciation for science. For some students, it is good to see a practical application for what they've been learning in class. For other students, it makes them more curious to learn about math and gain a deeper understanding of what is going on. Using the modules adds validity to what they've been doing in class, and what math teachers have been teaching them for years.*

> *The depth [of the NASA Now's] was engaging for them, and they were interested because the topics were different. Black Holes, microbes, extremophiles are not normally covered with my students. They like learning new things. I can tell they are engaged because they don't shut up! They have lots of good discussions.*

> *When I say we're going to go on NASA on the computer they go crazy, and then if I say we're not going to (due to behavior), they get upset. I love how NASA Now pulls in different things—the kids are always interested.*

Many teachers (29) also reported viewing positive changes in student comprehension of STEM content as a result of NES activities. Only one teacher reported seeing no change in student comprehension. Teachers provided examples of ways in which NES had influenced student comprehension:

> *These experiences are things they would not receive had I not participated in this program. It's not in the textbooks; it's not in the curriculum. And my job is to find content resources that help their critical-thinking skills and challenge them. I work in an economically disadvantaged area, and it's my job to challenge them and give them opportunities. I expect them to be critical thinkers and think at high levels. And I think these materials help me raise their level of comprehension and engagement.*

> *Their comprehension has deepened. I can compare student test scores from last year (without the use of NES materials) to this year. Scores have gone up. Student writing is now more complete and detailed, and students reference the NES modules.*

> *Anytime I do anything other than giving a lecture is always better. A lab is better, and then for the lab to be so nicely organized helped them to understand what they were doing and why it was important. I felt like their comprehension of heat transfer was better because they could actually build things and see the effects of what they built within 30 minutes—that helped them understand what they had been talking about in class.*

Finally, only eight teachers reported that NES materials exposed their students to careers they otherwise would not have considered.[10] These teachers noted that the NES activities improved students' confidence in their own abilities and helped them to aspire to eventually work in STEM careers. For example, as one teacher noted, students have become more aware of possible STEM careers because "NASA brought the world beyond the classroom walls to the students." As another teacher noted:

> *The excerpts of real people talking about what they do and how they use it in their jobs has broadened the students' understanding. My school is about 2 hours from any major city so the students don't have professional role models readily available to them.*

3.9 Teacher Recommendations for Improvement

While many teachers held a positive view of the NES materials, most cited at least one challenge or barrier to implementation that they had experienced when participating in this program (79 of the 86 respondents). These barriers were experienced both by non-implementers and more active NES users.

In addition to the specific issues encountered with the individual components (described above), some broader challenges emerged. One common barrier, cited by 19 teachers, was that it was difficult to incorporate NES materials into the curriculum due to district and state teaching requirements and testing schedules. For instance, some teachers reported that their district had a "same page, same day" policy, which left them little flexibility to use materials outside the approved curriculum. Other general problems or barriers included the timing of the live events (10 teachers), and timing within the school year (e.g., teachers signed up for the program too late to implement the materials with this year's class; 15 teachers). A related, but somewhat distinct problem reported by 26 teachers was that they could not implement all the materials they wanted because of time restrictions; they were often too busy to preview the materials prior to implementing them with students, to determine how to integrate the materials into the curriculum, or to learn how to use the materials as intended. This unfamiliarity with the materials, and lack of time to review them, is one of the likely causes of partial participation. Finally, two teachers were uncertain about the value of the NES materials.

A challenge for the NES project was a blurred boundary or confusion about NASA versus NES. Specifically, 19 teachers indicated in their responses that they had difficulty with or were unable to determine which materials were NES materials and which materials were other general NASA materials.

Teachers made many recommendations for changes to the NES project. Many centered on the use of the website, the materials, and technology. Others dealt with the specific content of the materials, while the remaining recommendations centered around support and communication.

[10] Teachers were not specifically asked whether NES had an effect on students' interest in STEM careers. In most cases, they were asked about changes in comprehension and engagement.

As noted in various sections, teachers often experienced difficulty finding the materials they were searching for on the Virtual Campus. Therefore, a common recommendation (specifically noted by 17 teachers) was to provide users with a better navigational and/or sorting mechanism on the Virtual Campus. For instance, some teachers wanted the ability to sort by content standard, while others wanted to sort by topic across NES elements, and across NASA programs. As one teacher noted:

> *I would like to see links between NES and the main NASA website. I had a difficult time indexing and searching the NASA website since every department is separated and it can make it hard to find what I am looking for. Everything needs to have clear links to other materials.*

Teachers also mentioned a desire to be able to archive materials they have used with their students (to find them easily again) and some wanted NES to provide access to archives of older materials, in addition to the modules, NASA Now's and ePDs that were currently available on the site.

In terms of material content, respondents suggested augmenting NES's resources on both the high and low ends of the age and ability spectrum. Almost equal numbers wanted more materials available for elementary grades (six teachers), as wanted more sophisticated work for high school juniors and seniors (including AP students). Along these lines, a small group of teachers (five) requested specific modification instructions for adapting lessons for higher/lower grades or ability levels. As one teacher stated, "It would be helpful to provide tips or hints for teachers who are limited in their resources or time, or how to adapt the materials for younger students or students who are at different levels."

Some teachers (six) also suggested that students should be able to access and use the Virtual Campus in addition to teachers; as one teacher explained, her students' symposium projects were based on the NES materials, and she had to go on the website and download all the relevant information they needed. She felt that it would have been easier if students could access the site on their own.

Teachers also made suggestions for improvements for the use of technology. Specifically, where it is indicated that technology should be used, some teachers would like more explanation of *how* to use it with their students. Additionally, teachers requested more instruction about how to link materials to areas of technology in general. As one teacher noted:

> *NES should constantly upgrade and tweak the materials with updates based on feedback from teachers. The materials should be more technology-friendly. For example, instead of just saying that you can use a camera with an activity, they should explain how to use the camera with the activity.*

Finally, some teachers indicated a desire for in-person support. Seven teachers in total remarked that they appreciated the in-person support from a regional liaison that came with the historical NES model. Other requests for additional support were more varied in their targets; they included more help with navigating the Virtual Campus, help with finding materials and dealing with problems that occur during this process (e.g., dealing with invalid links), and support for implementing additional supplemental activities with students.

4 Discussion

Below we discuss the key implications for the NES project, stemming from our investigation of the study's research questions.

4.1 Implications of Findings

4.1.1 Characteristics of Schools, Teachers, and Student Participants

NES registrants represent a wide range of backgrounds. The registrants themselves are teachers, administrators, and other educators, and span grade levels and subjects taught. In addition, they come from diverse geographic regions and locales. Their schools range in the demographic characteristics of the students they serve, and their classrooms span both advanced and remedial classes. This diversity demonstrates the widespread appeal of NES, and provides one indicator of successful recruiting in the project's first year. However, the diversity of the participants also poses a challenge to the program. Specifically, teachers look to NES for materials tailored to their specific needs. Therefore in order to meet the specific needs of such diverse users, NES must offer a large breadth of material and support services, with less depth in any single area.

4.1.2 NES Components Provided

Teachers looked to NES for materials that supplement or fit within their curricula. Thus, the classroom modules were often the component that drew the teachers. However, NES provides additional valuable resources to support teachers' use of the materials in the form of content and pedagogical professional development through the ePDs, the Help Desk, and other classroom materials (e.g., NASA Now events) that can be integrated into the classroom. In addition, NES showcases how materials and best practices have been implemented in actual classrooms. These serve as valuable resources that provide other educators with examples of how they might implement materials and practices.

NES provides access to expert-reviewed quality NASA STEM classroom materials, as well as related components developed by NES (e.g., ePD and NASA Now). NES serves as a central repository where these materials have been packaged in a single place to facilitate access by educators. However, respondents revealed that some confusion exists about the distinction between NES and NASA education more generally. This was particularly evident among NES registered teachers who knew they could access NASA educational materials through the NASA education website, and who were aware that the ePDs could be attended without registering for NES (i.e., through NSTA).

The NES project recognizes this and is making efforts to develop the NES brand in a way that is recognizable and that highlights the value-added of the NES project. We believe that this will be important both to the external education community and to the NASA community.

NES has provided a service to NASA by reviewing and identifying the high-quality curriculum materials that have been developed. In addition, the ePDs can support the use of the materials as intended. However, NASA education more generally is not leveraging the work of NES. For example, the NASA pages that house the curriculum materials do not provide links to NES. Thus, a teacher who comes across a NASA module through the general NASA education website is not made aware

that there are professional development resources available through NES. While such links might require coordination beyond the scope of the NES project, such coordination would likely benefit educators and NASA education more generally.

While NES provides these various components, it was not always evident to teachers the span of offerings, or sometimes the value-added that NES offers above what NASA education more generally provides. On a related note, the value of registering for NES for more than one year was not always apparent. The addition of modules will provide a source for new materials that may attract returning teachers. However, we and NES recognize that the pool of NASA-developed materials from which to draw new materials is limited and may soon be exhausted.

4.1.3 Components Accessed and Used

All components of NES were being accessed and used. However, we do not have complete information on which if any NES materials a large proportion of registrants were using. Usage pattern can be gleamed from users' completion of the surveys corresponding to the individual components, and these, coupled with information from interviews, indicate that not all registered users actually use the NES materials. Specifically, while there were 1,503 registrants as of June 1, only 93 completed a module survey, 125 completed an ePD survey, and 116 completed a NASA Now survey; only 73 users completed at least one module, one ePD, and one NASA Now survey. While individuals who have not completed surveys may be using NES materials, there is no mechanism for tracking who uses what and how frequently.

The usage patterns suggested by the completed surveys and supplemented by the interview data suggest that caution should be exercised when publicizing the reach of NES using registered users as the source. That is, although 1,503 teachers had registered for NES as of June 1, 2011, not all these teachers were using NES, and we cannot provide an accurate measurement of how many teachers were actually using the materials. Thus, it may be an overestimation to state that students of all 1,503 teachers were exposed to NES materials.

The existing mechanisms have not tracked actual use of NES materials, thus information is lacking on the people who sign up and do not complete surveys. While the interviews provide information suggesting that possibly half of the people who have not completed surveys have used some NES materials, this estimate may be inflated by selection bias as teachers willing to participate in the interview may be those more likely to be using NES materials.

4.1.4 NES Implementation in Classrooms

There is wide variation in how the materials are being used. A subset of teachers appears to have been accessing and using each component of NES related to their classroom instruction, but others were just utilizing some of the NES components; that is, some were just using the curriculum modules, or just showing NASA Now videos in their classrooms.

Teachers were supplementing their curriculum with NES materials, rather than building a curriculum around NES materials. Teachers were implementing materials in diverse settings with diverse audiences. They were more likely to select materials based on topic, rather than intended audience;

this was especially true for the NASA Now videos. Once teachers selected materials, they then modified the materials to fit their students and their lesson.

Respondents' suggested improvements to the program were often very specific to individual needs stemming from their specific curriculum or external pressures. Some of these comments reflected the desire for more individual guidance or support, specifically for identifying materials that are relevant to their own curriculum, thinking about ways in which the materials align with state standards, and how they can be modified to fit the needs of students.

Teachers commonly modified the NES classroom materials. One issue to potentially monitor is whether these modifications resulted in implementation that differs in important ways from the intent of the developers of the materials and of NES. For example, in response to teacher feedback during the NES pilot, NES made the materials available in small units that could fit within teachers' larger curricula. If original developers, however, intended for units of components to build on each other, then this modification may alter the original intended outcomes for the materials, even as it facilitates classroom use.

4.1.5 Supports for Use of NES

Teachers were supporting their use of NES in a variety of ways. Some teachers found that the materials were transparent and easy to implement and that no additional supports were necessary. Others relied on the ePDs to provide them with background and additional information on the content or pedagogical strategies for the materials. In addition, several teachers commented that they had problems finding materials and navigating around the site. Currently, modules have prominent links to related ePDs and less prominent links to related NASA Now's. In contrast, only some NASA Now's have some links to teaching materials. Also, there were no direct links between NASA Now events and ePDs. While there are currently some links, these results imply that further support for the use of the materials could be facilitated by providing additional links between related materials. NES might consider whether these links should be more explicit or consistent across materials.

4.1.6 Barriers to Implementation and Reasons for Partial Participation

The results of our analyses suggest that barriers to implementation and reasons for partial participation were similar. These included issues with technology, an absence of time, and specific testing or curriculum requirements that needed to be met.

Because the majority of respondents were individuals who were active participants in NES, we have more data about reasons for partial implementation and less information about any potential barriers that might result in no implementation. Thus, there is still a lot unknown about barriers to participation, because we did not talk to the large population of registered users who did not complete a survey.

4.1.7 Users' Impressions

Overall, users' impressions of the materials were generally positive, and teachers and students seemed to like the materials. Teachers reported using the Virtual Campus with minimal difficulty, although some issues were cited. Users' comments underscored the importance of NES

differentiating itself from what is readily available via NASA education. Teachers were not always clear that the materials they were using were from NES specifically rather than NASA more generally.

NES efforts to identify and market the value-added of NES—both internally at NASA and externally to the larger education community—may help ameliorate this difficulty. In part, the value of NES lies in that it is not just a resource for classroom materials, but a source of support for these materials, and a place where these are coupled.

Teachers who participated in the recognition programs liked them. However, these recognition opportunities did not always serve as motivators for participation in NES or changes in practice.

4.1.8 Best Practices

There is limited evidence that teachers were employing the best practices that NES advocates, and in instances where elements of best practices were noted, it was often not specific to NES. Teachers were using technology to varying degrees, but their interpretation of what is meant by technology varied. Very limited involvement of families and communities was reported. While the application for the recognition opportunities is one way that NES promotes the use of best practices, it is questionable whether these opportunities motivate teachers—to use materials, to complete surveys, or to employ best practices at all. Thus it seems appropriate for NES to revisit the question of whether these recognition opportunities serve as a viable mechanism for changing teacher practice. Monitoring whether the same teachers participate year after year, or whether new teachers are engaged in these activities, seems important given the great effort and resources required by these opportunities. Further, NES may consider whether there are means of building support for best practices through the materials and being explicit about expectations for best practices up front, rather than through recognition opportunities that are available after the use of materials.

4.1.9 Teacher and Student Outcomes

Teachers perceived benefits, both for themselves and their students, associated with using the NES materials. Teachers were generally comfortable with the materials and feel prepared to use them in the classroom. Similarly, there was evidence that teachers were more confident with STEM content, including scientific disciplines outside their own, after using the NES materials. They also reported that their students were engaged with the NES materials. Some reported that the materials enhanced students' comprehension of STEM content, and increased their interest in STEM-related to careers. While no direct measures of the outcomes of interest were available, these reports suggest that if NES is implemented as intended, it may result in the intended outcomes for teachers and students.

4.2 Summary and Next Steps for the Evaluation

In summary, there have been many successes in the first full year of NES implementation. NES has attracted users from a wide range of backgrounds and educational settings. While this reflects the success of NES recruitment, it also poses challenges to NES support of teachers. The data gathered during the Year 1 evaluation suggest that that teachers who used NES materials were satisfied

overall with the NES project, although not all registrants were implementing NES. Year 2 evaluation activities are structured to more carefully explore actual choice and implementation.

NES users typically were looking for supplemental teaching materials, and they were looking for materials that fit within their existing curriculum or teaching requirements. The individuals who participate in NES were a self-selected group, motivated to find materials to augment their instructional curriculum. Although actual usage data across the registered users was limited, available project and interview data suggested that some teachers engaged with each of the key NES components—modules, ePDs, and NASA Now events—while others were selective in what they implemented. Educators looked to NES to provide supplemental teaching materials, and thus identified and used modules that aligned with their curriculum, and modifications of the materials were common. Study participants reported that the NES project offered valuable resources, and users were able to identify benefits of NES participation that accrued both to themselves and their students. Suggestions for improvement were often related to very specific needs of the individual educator.

The study also identified some challenges that the NES project faces as it moves forward. Individuals who registered for NES were not always able to distinguish what they accessed through NASA more generally from what they accessed through NES, and some raised some questions about the value-added of NES above what was available more generally through NASA. Finally, it was not clear that teachers were systematically employing the best practices identified by NES, or that the recognition opportunities served as motivation to engage in these practices. These themes will be further explored in Year 2 of the evaluation.

The Year 2 Evaluation activities will consist of gathering information about project implementation from NES participants through teacher surveys and teacher logs, and measuring baseline and post-program values on outcomes of interest through teacher surveys and student surveys. In addition, focus group interviews will be conducted with students in a small subset of classrooms. The use of teacher logs should provide further insight into what components are accessed and implemented by NES users. In-depth implementation data will be gathered through real-time implementation tracking program via teacher logs. In addition, the evaluation will use a pre-post design to gather data from teacher and student participants to see whether there are changes in intended outcomes as measured before and after participation in the NES project.

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