Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Outcomes Report

Contract No. NNH08CD70Z, Order No. NNH13CH35D

June 4, 2014

Prepared for:
National Aeronautics and Space Administration (NASA)
Office of Education

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SoI Stand-Alone Program Model FY2013 Evaluation Plan

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Acknowledgements

This report was prepared with assistance from our colleagues Amanda Parsad, Elisabeth Ericson, Gabe Schwartz, Amy Checkoway, Nicole Brooke, and Erica Fields. This report is the result of the collaborative effort involving numerous other individuals. The authors of this report would like to thank the evaluation leads at the individual NASA Summer of Innovation (SoI) camps, Awardees, and NASA Centers and the Jet Propulsion Laboratory for their assistance in providing information and materials on their SoI programming. We are indebted to the individuals at the camps who shared their time and participated in interviews and focus groups with the site visit teams, as well as the SoI students and parents who participated in the evaluation data collection activities. We also would like to thank the members of the evaluation team from Abt Associates and Education Development Center who helped plan and conduct data collection activities. Further, we thank Harvard University's Program in Education, Afterschool & Resiliency (PEAR) for providing training on the Dimensions of Success observation tool and for sharing their Common Instrument Validation data with the study team as well as Sara Spiegel, Director of Administration at the Noyce Foundation, for supporting access to the Common Instrument Validation data. Finally, we would like to thank the NASA staff members and contractors, as well as members of the SoI Technical Review Forum including Henry Frierson, University of Florida; Anita Krishnamurthi, Afterschool Alliance; Laura LoGerfo, the Project Officer for High School Longitudinal Study of 2009 at the U.S. Department of Education National Center for Education Statistics; Gil Noam, Founder and Director of the Program in Education, Afterschool & Resiliency (PEAR), Harvard University; Carol Stoel, National Science Foundation; Robert Tai, University of Virginia; and Diego Zapata-Rivera, Educational Testing Service, who have provided guidance on the framing and design of this evaluation and feedback on its findings.

The data collection, analysis and reporting of this material was conducted in accordance with OMB Control No. 2700-0150 (expiration February 28, 2015).

Executive Summary

The National Aeronautics and Space Administration (NASA)'s Office of Education launched the Summer of Innovation Project (SoI) in 2010 in response to President Obama's "Educate to Innovate" campaign. SoI is a multi-year project intended to engage the nation's youth in NASA's broad mission and to inspire them to pursue education in science, technology, engineering and math (STEM) fields leading to involvement in the country's STEM workforce. SoI provides middle school students, including those who are traditionally underrepresented and underserved in STEM (i.e., females, minorities excluding Asians, and low-income students), with opportunities to engage in NASA-developed activities during the summer.

In fiscal year 2013 (FY2013), the SoI project operated through NASA Centers and SoI Awardees that were previously selected through a competitive process. NASA sought to provide its Awardees/Centers and their collaborators or partners with tools to offer high-quality STEM opportunities to middle school youth, while also allowing Awardees/Centers to leverage their own resources and expand their capacity to influence the educational trajectories of students underrepresented in the STEM fields.

The 2013 evaluation efforts focused on investigating the SoI stand-alone model, which holds particular promise as a summer engagement model for middle school students that may be replicable across Federal Government programs. Camps implementing the stand-alone model offer middle school students a minimum dosage of 30 hours of selected NASA SoI curricula, independent of other summer programming.

This report, the third in a series of reports from this evaluation, presents findings related to outcomes of interest to SoI. The first report described how camps document and prepare performance data submitted to NASA, and the second report presented findings related to the implementation of SoI activities in summer 2013.

Using a one-group, pre-post comparison design this report assessed whether there were observable changes in SoI students' interest and engagement in science, how SoI student outcomes compared to other middle school students, and explored if and to what extent outcomes varied by camp quality and characteristics. Student and parent surveys, Harvard University's Program in Education, Afterschool & Resiliency (PEAR) Common Instrument Validation (CIV) dataset, site visits, interview and focus group data, and project performance data provided evidence to generate the following key findings:

- A comparison of student extracurricular science activities in the 2012-2013 school year to similar activities in the fall of the 2013-2014 school year showed that there were some activities (science club and science study groups or tutoring) in which more students reported participating in the fall of 2013 after participation in SoI, while there were other activities (science competition and science camp) in which a smaller percent of SoI students reported participating in the fall of 2013.
- There were no systematic patterns of differences in extracurricular science activity participation among the subgroups explored, including gender, grade, underrepresented racial/ethnic group, and parental education.
- Baseline survey data demonstrated that students expressed high existing interest in key SoI outcomes prior to the start of the summer activities. Nonetheless, in the fall students rated even higher on measures of enthusiasm for science, interest in design/hands-on activities, interest in out-of-school

STEM activities, and general interest in science. The results suggest minimal but statistically significant increases in self-reported enthusiasm for science and interest in out-of-school STEM activities between the baseline survey and the fall follow-up survey.

- Exploration of potential subgroup differences found that students from racial/ethnic groups underrepresented in STEM, on average, had a larger positive change from baseline to follow-up in their enthusiasm for science and interest in out-of-school STEM activities than did students not from underrepresented racial/ethnic groups (i.e. Whites and Asians). Also, students whose parents had an Associate's Degree or higher had larger average positive changes in their enthusiasm for science compared to peers whose parents had completed less education.
- Compared to their peers starting other out-of-school STEM programs, students who participated in SoI expressed higher interest in science, as measured by the Enthusiasm for Science scale, prior to the start of the summer activities. Similarly, SoI students expressed greater interest in science in the fall compared with the interest expressed by peers at the completion of other out-of-school STEM programs. Further, SoI students scored higher on selected science-related National Assessment of Educational Progress (NAEP) items than both the NAEP national sample and their comparison peers in other STEM out-of-school programs.
- Associations between key camp characteristics and student outcomes were observed. Namely, the larger the percent of certified teachers the greater the increase in interest in out-of-school STEM activities. Also, a higher educator-to-student ratio was associated with more positive change on the Enthusiasm for Science scale and general interest in science.
- Classroom quality also appears to be related to student outcomes. Camps with higher quality classrooms were associated with larger increases in student science engagement.

Based on the findings of this report, SoI and other NASA out-of-school time STEM programming should consider the following recommendations when making future program improvements:

- Continue to emphasize the importance of incorporating hands-on and problem solving activities in SoI, as students and teachers both reported that these were the most compelling aspects of SoI, and increase the proportion of camp time and professional development support available for these activities.
- Attention to the types of activities engaged in during SoI could provide insight into why particular students are attracted to SoI and how programming could be structured to foster the greatest long-term interest in STEM.
- Encourage camps to consider employing K-12 certified teachers and maintain educator-to-student ratios of 1:20 or higher as these staffing strategies appear related to more positive changes in student interest and engagement in science.
- Students may have many experiences, both in and out of school, that affected their interest and engagement in STEM in between their participation in SoI during the summer and the survey administration in late fall of the subsequent school year. These additional experiences make it difficult to attribute any observed changes to SoI participation. If establishing a more direct link between SoI participation and change in STEM interest and engagement is of interest to the project, future evaluation efforts could include a contemporaneous comparison group and measure student outcomes at the start of the camp and close to the conclusion of SoI camp.

- Future evaluation could include a larger sample of SoI camps to better understand variation in student outcomes attributable to camp characteristics. The correlational analysis of camp characteristics and student outcomes was limited to characteristics that varied across study sites and to those for which there were available data.
- Continued use of the PEAR Dimensions of Success (DoS) tool to assess camp quality will likely provide additional valuable information about successful implementation of SoI and how camp quality relates to student outcomes. Further, supporting camp staff to improve the quality of the experiences they provide, particularly on dimensions that camps were rated lower on such as student reflection, relevance of activities for students' lives, and student understanding of STEM concepts could result in larger increases on outcomes of interest.
- The SoI project has successfully engaged a large proportion of students from groups that are traditionally under-represented in STEM. However, SoI students' high levels of motivation have implications for future considerations around recruitment and outreach. Future evaluation efforts could examine recruitment procedures.

1. Introduction

In order to support NASA's vision of equal access to a quality STEM education, the Summer of Innovation engages and supports external partners in the delivery of evidence-based summer engagement opportunities in STEM to youth from underserved/underrepresented populations with the intent of increasing interest and participation in STEM and contributing toward the national-level impact of increased numbers of high school graduates pursuing STEM majors and careers.[1]

-Goal statement of NASA's Summer of Innovation project

Responding to President Obama's "Educate to Innovate" campaign, which aimed to improve education in science, technology, engineering, and mathematics (STEM) for American youth,[2] the National Aeronautics and Space Administration (NASA) launched the Summer of Innovation (SoI) project in 2010. SoI is a multi-year project intended to engage the nation's youth in NASA's broad mission and to inspire them to pursue education in STEM leading to involvement in the country's STEM workforce. Through partnerships with educators, STEM learning networks and a variety of organizations, SoI provides middle school students, including those who are traditionally underrepresented and underserved in STEM (i.e., females, minorities excluding Asians, and low-income students), with opportunities to engage in NASA-developed activities during the summer.

In fiscal year 2013 (FY2013), the SoI project operated through the NASA Centers and Jet Propulsion Lab (JPL) and SoI Awardees (collectively referred to as Awardees/Centers) that were previously selected through a competitive solicitation process. NASA Centers received SoI funds, 2010 Awardees received no-cost extensions, and 2011 Awardees received another phase of their grant award. NASA sought to provide its Awardees/Centers and their partners[3] with tools to offer high-quality STEM opportunities to middle school youth, while also allowing Awardees/Centers to leverage their own resources and expand their capacity to influence the educational trajectories of students underrepresented in the STEM fields.

Reflecting a commitment to evidence-based decision making, NASA's Office of Education contracted with Abt Associates Inc. and its subcontractors, Education Development Center (EDC) and DataStar (collectively referred to as the study team) to conduct the *Evaluation Study of NASA's Summer of Innovation (SoI) Stand-Alone Model FY2013* during SoI's fourth year of operation. The study team engaged in evaluation activities with the following key objectives: (1) document the processes and supporting materials for the performance data submitted to NASA by Awardees/Centers; (2) identify the key components of successful implementation of SoI stand-alone activities and the primary challenges to implementation; (3) estimate short-term changes in student outcomes after participation in SoI; and

1 NASA, 2012. *Summer of Innovation: Project Redesign and Evaluation*. Report to the Executive Office of the President, Office of Management and Budget, p.6.

2 November 23, 2009. The White House Office of the Press Secretary. President Obama Launches "*Educate to Innovate" Campaign for Excellence in Science, Technology, Engineering, and Mathematics (STEM) Education*. Retrieved December 11, 2011, from http://www.whitehouse.gov/the-press-office/president-obama-launches-educate-innovate-campaign-excellence-science-technology-en.

3 Organizations that partner with NASA Centers are officially designated as "collaborators" and those that partner with Awardees are "partners"; the term "partners" is used throughout this report to refer to both.

(4) explore the relationship between SoI camp quality, as measured by the Dimensions of Success tool,[4] and student outcomes.

The 2013 evaluation efforts focused on camps operating SoI independent of other summer programs (i.e. the stand-alone model). While some camps infuse NASA content and activities into pre-existing programs, the SoI stand-alone project model offers middle school students with a minimum dosage of 30 hours of selected NASA SoI curricula during the summer. SoI curricula feature hands-on, problem-based activities in an appropriate learning progression. NASA believes the stand-alone model holds particular promise as a summer engagement model for middle school students that may be replicable across Federal Government programs.

Together with the monitoring activities that NASA conducts, the 2013 evaluation helped to: document how Awardees/Centers collect and report performance data to NASA; understand successes and challenges in implementing SoI requirements within the SoI stand-alone model; estimate changes in student outcomes after participation in SoI; and investigate the relationship between SoI camp quality and student outcomes. The evaluation was designed to answer the following research questions related to implement and outcomes:

Implementation

1. What are the characteristics of SoI camps and their participants?
2. To what extent do SoI camps meet program quality expectations as defined by the PEAR Dimensions of Success (DoS) rubrics?
3. What supports and challenges do Awardees/Centers face in implementing SoI curricula? How do they handle these challenges?
4. What staff, materials, and NASA resources are necessary for successful SoI activities?
5. How early and to what extent must plans and preparation begin for successful project implementation?[5]

Outcomes

6. Are SoI students' levels of STEM interest and engagement similar at the start of SoI and in the fall?
    a. Do students report participating in STEM—in-school, extracurricular, or out-of-school—more frequently since SoI participation than they did in the previous school year? Are there differences by subgroups (e.g., gender)?
    b. Did self-reported interest in STEM change significantly between the baseline and follow-up surveys? Are there differences by subgroups (e.g., gender)?
    c. To what degree does SoI youth self-reported interest in STEM at follow-up differ from youth involved in other out-of-school time programming?
7. Are there correlations between camp characteristics and project quality and the student attitudes and behaviors?

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[4] See http://caise.insci.org/sparks/128-dimensions-of-success-dos-afterschool-science-observation-tool for more information about the DoS.

[5] Information on the processes and materials that camps use to register students for SoI will also be provided as necessary to supplement the information that NASA obtains through its own efforts.

This report, the third in a series of reports from the FY2013 evaluation, presents the evaluation's findings related to student outcomes of interest to SoI, addressing research questions six and seven.[6] It begins with a brief overview of SoI, which draws on information gleaned from previous evaluations. The next section describes the evaluation design and methodology used to analyze both qualitative and quantitative data. The following section reports the findings based on student baseline surveys, student follow-up surveys, the Common Instrument Validation (CIV) dataset, parent surveys, camp registration, and camp observations. The report concludes with a discussion of the findings related to the specific research questions and recommendations for future SoI programming.

[6] The first report described how camps document and prepare performance data submitted to NASA. The second report presented findings related to the implementation of SoI activities in summer 2013, addressing questions one through five.

2. SoI Project

During fiscal year 2013, which represented SoI's fourth year of operation, SoI funds were provided to NASA Centers as well as SoI Awardees that were previously selected through a competitive process. Through the Awardees/Centers, SoI focused on providing intensive and interactive summer STEM experiences to underrepresented, underserved students entering 4^{th} to 9^{th} grades. NASA also awarded mini-grants to a range of educational partners (e.g. museums, schools or school districts, youth organizations) to integrate STEM content into existing summer and after-school student programs.

The SoI project model aligns with existing literature on enhancing student interest and engagement in STEM, particularly in informal settings.[7] A key component of the SoI programming through the Awardees/Centers was the integration of selected NASA content in hands-on, problem-centered and inquiry-based STEM activities to create summer enrichment experiences for students. To support these unique summer learning experiences, SoI provided professional development opportunities for educators that focused on the implementation of the NASA content during the summer program.

Research indicates that hands-on, inquiry-based activities delivered in informal environments are key factors in helping to develop critical thinking skills and play a significant role in increasing students' interest and engagement in STEM and the likelihood that they will consider science-related occupations.[8] SoI aims to foster students' interest and involvement in STEM activities, and ultimately, to increase the overall number of students pursuing STEM degrees and related careers and, more specifically, increase the proportion of underrepresented students who pursue these paths.

2.1 Grounding in Research Base

A number of factors are associated with students' continued participation in STEM disciplines, and ultimately, their pursuit of STEM careers. An important factor is student interest in STEM. Research indicates that hands-on, inquiry-based activities play a significant role in increasing students' interest and engagement in STEM and are key factors in the development of their critical thinking skills. The literature suggests that when students manipulate objects they engage longer and form a better understanding of how things work. Through hands-on explorations students ask more questions, develop strategies to problem-solve, and incorporate other skills into their learning, which leads to a deeper understanding of the material.[9]

Active learning encourages the development of communication skills, higher-level thinking skills, a positive attitude towards the subject, and increased motivation to learn.[10] In recent studies, high school

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7 A review of relevant literature investigating the relationship between informal science education and student engagement in STEM, with a particular emphasis on the middle and high school levels, was conducted by EDC under a previous contract with NASA. See Fournier, R., DeLisi, J., & Levy, A.J. (2011). *NASA Summer of Innovation (SoI): Informal science education and student engagement.* Newton, MA: Education Development Center, Inc.

8 National Institute on Out-of-School Time. (2007). *A Review of the Literature and the INSPIRE Model: STEM in Out-of-School Time*. Wellesley, MA: Wellesley College.

9 Minner, D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—What is it and does it matter? Results from a research synthesis. *Journal of Research in Science Teaching*, 47(4), 474-496.

10 Sirinterlikci, A., Zane, L., & Sirinterlikci, A. L. (2010). Active learning through toy design and development. *The Journal of Technology Studies*, 35, 14-22.

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.[11] Middle school camp participants rated hands-on, laboratory-based engineering workshops as being engaging and enjoyable, as well as related to their improved understanding of the subject.[12]

Many STEM out-of-school (OST) programs primarily focus on motivation and engagement outcomes rather than student learning. Common non-learning outcomes include attitudes toward STEM; engagement with or interest in STEM; confidence, self-esteem, or self-efficacy; self-reported science or technology skills;[13] and interest in, knowledge of, or pursuit of STEM majors and careers.[14] OST programs have demonstrated significant increases in such outcomes. For example, participants in a middle school robotics and geographic information system (GIS) summer program showed a significant increase in self-efficacy and attitude toward science.[15] An information technology camp for Hispanic middle school students generated a significant increase in attitude and interest in information technology.[16] Another OST program for underrepresented middle school students demonstrated significant increases in confidence, value placed on STEM, and future intentions regarding STEM.[17] A multiyear evaluation of a summer program for middle and high school girls demonstrated a slight improvement in attitude toward math and knowledge of STEM careers.[18] In another program for middle school girls, half of the participants reported changing their career plans because of the program.[19]

Through hands-on activities and projects, SoI is designed to engage students actively with STEM content. As such SoI has the potential to increase students' STEM interest and engagement.

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11 Merrill, C., Custer, R. L., Daugherty, J., Westrick, M., & Zeng, Y. (2008). Delivering core engineering concepts to secondary level students. *The Journal of Technology Education*, 20, 48-64.

12 Dave, V., Blasko, D., Holliday-Darr, K., Kremer, J. T., Edwards, R., Ford, M., et al. (2010). Re-enJEANeering STEM education: Math options summer camp. *The Journal of Technology Studies, 36,* 35-45.

13 Ault, P. C. (2005). *Annual report: Salmon Camp Research Team*. Portland, OR: Oregon Museum of Science and Industry.

14 Goldstein, D. (2008). *The evaluation of COSMOS (2000-2008): Developing future scientists, engineers, and mathematicians.* Berkeley, CA: Lawrence Hall of Science, Center for Research, Evaluation and Assessment, University of California. Retrieved July 1, 2011 from http://www.ucop.edu/cosmos/documents/eval_report.pdf

15 Nugent, G., Barker, B., et al. (2010). Impact of robotics and geospatial technology interventions on youth STEM learning and attitudes. *The Journal of Research on Technology in Education, 42*(4), 391-408.

16 Hayden, K., Ouyang, Y., Scinski, L., Olszewski, B. & Bielefeldt, T. (2011). Increasing student interest and attitudes in STEM: Professional development and activities to engage and inspire learners. *Contemporary Issues in Technology and Teacher Education, 11*(1), 47-69.

17 Crombie, G., Walsh, J.P., et. al. (2003). Positive effects of science and technology summer camps on confidence, values, and future intentions. *Canadian Journal of Counselling, 37*(4), 256-269.

18 Harvard Family Research Project. (n.d.). *A profile of the evaluation of Girls Incorporated—Thinking SMART Program.* Cambridge, MA: Author. Retrieved July 27, 2011, from http://hfrp.org/out-of-school-time/ost-database-bibliography/database/girls-incorporated-thinking-smart-program

19 Harvard Family Research Project. (n.d.). *A profile of the evaluation of SECME RISE (Raising Interest in Science & Engineering)*. Cambridge, MA: Author. Retrieved July 27, 2011, from http://hfrp.org/out-of-school-time/ost-database-bibliography/database/secme-rise-raising-interest-in-science-engineering

2.2 SoI Project Evolution

Maintaining consistent core components and goals, SoI has evolved since the project's start in 2010, and is briefly described below.

2.2.1 2010 Pilot

The SoI pilot in 2010 employed a multi-faceted approach to reach and engage middle school students in STEM learning with NASA content and experiences. NASA provided funding for SoI activities to the nine NASA Centers and JPL, awarded cooperative agreements through a competitive process to four Space Grant Consortia (Idaho, Massachusetts, New Mexico, and Wyoming) and contracted with one external organization (Paragon TEC Inc.). NASA also issued an open call inviting interested groups to use NASA content during their existing summer activities for students; however, no funding was provided.[20]

NASA's requirements differed for each of these groups. The four Space Grant Consortia and the contractor were expected to provide professional development to the educators who would lead the summer activities; implement intensive, hands-on activities to middle school students; infuse NASA content into the summer activities; develop a STEM community of learning for sustained engagement over a 36-month period; and evaluate the effectiveness of their programs.[21] NASA Centers in 2010 received fewer SoI resources than the Space Grant Consortia and the contractor and were operating under tighter time constraints. The Centers' SoI funding was provided to support collaborations with partners that offer summer camps for the targeted student audience and who agreed to provide at least 30 content hours in STEM - of which at least 7.5 hours were to be NASA content – during these camps. NASA Centers were not expected to provide professional development activities nor were they required to provide follow-up activities during the academic school year (although some did). Finally, NASA did not detail explicit expectations for the organizations that responded to the open call as they did not receive funding.

2.2.2 Summer 2011

Building on the pilot's successes and responding to the lessons learned NASA made significant changes to SoI for FY2011. For example, because of potential partners' limited ability to implement large-scale STEM summer experiences, SoI was refined to emphasize strengthening the capacity of community and school-based organizations to engage 4th through 9th grade students in NASA-themed intensive, high-quality, inquiry-based learning experiences. NASA also sought to build the sustainability of the Awardees' programs by encouraging partnerships with formal and informal STEM organizations so that they could eventually operate high-quality STEM programs at scale without additional SoI funding.

NASA continued to utilize multiple funding models for SoI in FY 2011. Four primary approaches were taken: 1) competitive national awards for large, proven providers of STEM learning experiences to the targeted student groups; 2) funding to the nine NASA Centers and JPL to support collaborations with small to mid-size organizations interested in enhancing their STEM activities; 3) continued funding to the 2010 pilot Awardees; and 4) mini-grants to various organizations desiring to engage students in NASA content.

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[20] SoI Planning Meeting Handout, April 2010, p. 4.

[21] FY 2010 Cooperative Agreement Notice (CAN) for the *National Needs Grant: Summer of Innovation Pilot* (announcement NNH10ZNE004C, January 27, 2010, p.12).

In May 2011, eight national awards were made to organizations implementing summer programs in Pennsylvania, Nebraska, South Dakota, Indiana, Georgia, Texas, California, and Puerto Rico. These national Awardees received the most funding, made the longest commitment, and were responsible for the greatest number of requirements. In partnership with schools, districts, or state departments of education, as well as community/professional organizations and partners, national Awardees were to provide students with 40 hours of STEM activities that utilized NASA content over the summer and an additional 25 hours of sustained engagement activities during the school year. They were also required to make certified teachers supporting summer learning and other certified teachers supporting SoI sustained engagement activities aware of NASA professional development opportunities, and to participate in a national evaluation by collecting parent consent forms, administering student and teacher surveys, and completing forms describing their activities.

The nine NASA Centers and JPL were required to be actively engaged in the SoI project and to collaborate with established organizations. These collaborations were to provide students with a minimum of 20 hours of NASA content over the summer, and the partner organizations were expected to implement two follow-up activities during the school year. Centers and their partners were also required to participate in the national evaluation by collecting parent consent forms and administering student surveys.

The third approach used by SoI in FY2011, facilitated by the Space Grant Foundation, was the mini-grant award, whereby small, one-time awards were made to various organizations that were interested in enhancing STEM opportunities for the targeted audience. These organizations were required to provide only a minimum of six hours of NASA-related programming to students.

2.2.3 Summer 2012

NASA continued to fund the five pilot Awardees selected in 2010, the eight national Awardees selected in 2011, the nine NASA Centers and JPL, and also continued mini-grants to various organizations. In 2012 programming requirements were similar to those in FY 2011; national Awardees were required to provide 40 hours of student STEM activities utilizing NASA content over the summer, while NASA Center partnerships needed to provide 20 hours of student STEM activities utilizing NASA content during the summer. For the national awards, organizations receiving SoI funding were required to direct certified teachers supporting summer learning and other certified teachers supporting SoI sustained engagement activities to NASA professional development opportunities; NASA Center partnerships were not expected to provide professional development for classroom teachers.

2.2.4 Summer 2013

In 2013, NASA continued funding the five pilot Awardees, the eight national Awardees selected in 2011, the nine NASA Centers and JPL, and also continued mini-grants to various organizations. Changes were made to the SoI requirements to better align the project goals with practical considerations in the field. The sustained engagement requirements were eliminated, funded Awardees and Centers were required to use the NASA SoI curricula, and the student-to-teacher ratio was expected to remain lower than 20 students to one teacher. Additionally, Awardees and Centers were required to offer outreach activities to parents or caregivers of students engaged in NASA activities.

During the summer of 2013, SoI continued its broad reach. The nine Centers, JPL and the eight 2011 national awardees collaborated with various organizations around the country to operate 690 camps that served over 39,000 rising fourth through ninth grade students and engaged over 4,000 educators.

3. Design and Methodology

Focusing on camps operating the SoI stand-alone model, the 2013 evaluation was designed to address the following key objectives: (1) document supporting records for the performance data submitted to NASA by Awardees/Centers; (2) identify the key implementation components of successful SoI stand-alone activities; (3) estimate changes in student outcomes after participation in SoI; and (4) explore the relationship between SoI program quality and student outcomes. Separate reports were prepared to present the findings related to the first two objectives,[22] while the approach and findings related to the third and fourth objectives are the focus of this report.

To address the third and fourth evaluation objectives, the outcomes evaluation used a one-group, pre-post comparison of survey responses to assess whether there were observable changes in outcomes of interest for students who participated in SoI. Key outcomes of science interest and engagement were also benchmarked against a national benchmarking sample of students who participated in out-of-school time programming using the Common Instrument Validation (CIV) dataset—developed by Harvard University's Program in Education, Afterschool & Resiliency (PEAR). To provide evidence about program quality, the evaluation employed site visits to assess the quality of classroom instruction provided to students, as well as content analysis of interview and focus group data to describe the approaches camps use to meet SoI requirements. To provide context for the exploration of student outcomes, this report provides data on key camp characteristics and revisits key findings about participants and program implementation.[23]

3.1 Research Questions for the Outcomes Evaluation

This report presents the findings related to the outcomes of interest to SoI, by looking across selected FY2013 SoI camps implementing the stand-alone model during the summer of 2013. It specifically addresses the research questions related to student outcomes, answering questions 6 and 7 from the larger evaluation:

Research Question 6. Are SoI students' levels of STEM interest and engagement similar at the start of SoI and in the fall?

a. Do students report participating in STEM—in-school, extracurricular, or out-of-school—more frequently since SoI participation than they did in the previous school year? Are there differences by subgroups (e.g., gender)?
b. Did self-reported interest in STEM change significantly between the baseline and follow-up surveys? Are there differences by subgroups (e.g., gender)?

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22 Martinez, A., Brooke, N., & Linkow, T. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Documentation of Performance Data*. Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA; Martinez, A., Linkow, T., Brooke, N., DeLisi, J., & Levy, A. J. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Implementation Report.* Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA.

23 Details on SoI implementation can be found in Martinez, A., Linkow, T., Brooke, N., DeLisi, J., & Levy, A. J. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Implementation Report.* Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA.

c. To what degree does SoI youth self-reported interest in STEM at follow-up differ from youth involved in other out-of-school time programming?

Research Question 7. Are there correlations between camp characteristics and program quality and the student attitudes and behaviors?

Information about characteristics of camps and their participants as well as some details on students' experiences in the camps are also included to provide context for the exploration of student outcomes. The evaluation used quantitative and qualitative data analyses to estimate change in student behavior and attitudes over time through a comparison of baseline and follow-up survey results, and to examine any correlations between SoI program quality and student outcomes. In addition, where available, comparisons were made to benchmark samples.

3.2 Study Sites

The FY2013 evaluation focused on selected sites that employed a stand-alone model, which holds promise as a replicable summer engagement program model. Camps implementing the stand-alone model offer middle school students a minimum dosage of 30 hours of selected NASA SoI curricula, independent of other summer programs. NASA identified a purposive sample of SoI stand-alone camps administered by Awardees or NASA centers for the FY2013 evaluation. The selected camps were all previously funded in FY2012. Camps were selected based on specific programmatic criteria. Eligible camps:

- Offered stand-alone SoI camp experiences, typically one week in length, utilizing NASA SoI curricula for a minimum of 30 hours during the camp; and
- Targeted rising 6th through 9th grade students.[24]

NASA also selected camps based on demographic and geographic diversity and the total number of students served. Logistical constraints were also considered, such as the feasibility of conducting site visits at multiple camps over the short camp operating timeframes and the ability to recruit students in the targeted grades. After identifying a pool of eligible camps, NASA and the evaluation team held a series of conference calls with staff representing each camp to gather information about camp length, dates, and projected size that was necessary to finalize the camp selection.

NASA identified a sample of stand-alone camps administered by four Awardees/Centers: NASA Glenn Research Center; NASA Johnson Space Center; Rio Grande Valley Science Association; and Chester County Intermediate School District. Eleven camps across these four Awardees/Centers participated in the FY2013 evaluation. Participation included student and parent surveys and interviews with PIs/center leads at all camps as well as site visits and teacher focus groups at eight of the 11 camps. The study sample includes rising 6th to 9th grade students and their parents from all 11 of these SoI stand-alone camps as well as the teachers, PIs, and center lead staff at these camps.

3.3 Data Sources

To explore the outcomes of SoI participants at stand-alone camps, the evaluation team analyzed data from various sources: parent surveys, student baseline surveys, student follow-up surveys, the Common Instrument Validation (CIV) dataset, camp site visit observations, teacher focus groups, NASA

[24] Rising 6th through 9th grade students were targeted because of SoI's focus on students in the middle school grades.

performance data, and camp registration data.[25] We describe each of these data sources below and discuss how the data were analyzed in the following section.

3.3.1 Parent Survey

Parent surveys were collected to provide background data such as parents' highest level of education achieved, whether or not they were employed in a STEM occupation, their children's experience with afterschool activities, and their reasons for enrolling their children in SoI camp (Appendix A). The parent survey was developed by NASA in collaboration with several external experts[26] and the study team. Surveys were available in English and Spanish. To address the research questions related to project outcomes, parent surveys were collected from 1,121 parents of 6th to 9th grade students participating in the 11 camps included in the evaluation.[27] The estimated response rate for the parent survey was 86% (see Exhibit 3.1).

Exhibit 3.1: Parent Survey Response Rates

Total Rising 6th-9th Grade Participantsa	Total Number of Surveys Received from Parents in the Study Sample	Response Rate
1,298	1,121	86%

[a] The total number of 6th-9th grade SoI participants is the number of students who either appeared on camp rosters or completed a baseline survey. Actual participation in SoI was confirmed during the follow-up period through telephone reminder calls.

3.3.2 Student Surveys

Two student surveys were developed: (1) a baseline student survey intended for administration on the first day of camp and (2) a follow-up survey that was mailed to students' homes in fall 2013. The student surveys were developed by NASA in collaboration with external experts[28] and the study team. The surveys also benefited from the feedback of SoI Awardee and Center representatives. The survey questions were selected to gather information from students about their demographic characteristics, educational plans, experience in SoI, interest in and enthusiasm for science, and their participation in organized and leisure science activities (see Appendices B and C for the survey questionnaires). The five survey questions pertaining to interest in and enthusiasm for science were selected and/or adapted from previously field-tested and validated instruments, eliminating the need for cognitive testing. The sources for these survey question items included:

- Student Baseline Survey, High School Longitudinal Study (HSLS) of 2009, IES/Department of Education;

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25 The 2013 evaluation activities also included teacher focus groups and interviews with Awardee PIs and center lead staff. These data sources informed the findings reported in the *Implementation Report*.

26 The external experts include: Laura LoGerfo, the Project Officer for High School Longitudinal Study of 2009 at the U.S. Department of Education National Center for Education Statistics; Gil Noam, Founder and Director of the Program in Education, Afterschool & Resiliency (PEAR), Harvard University.

27 In total, 1,447 parents of 6th to 9th grade students completed a survey but the evaluation team was unable to confirm through either camp rosters or student baseline surveys that the children of 326 parents ever attended the SoI camps included in the evaluation. The total number of parent surveys received from parents of actual SoI participants was 1,121 (1,447 minus 326).

28 See footnote 26 for a list of the experts who provide survey development guidance.

- Assessing Women and Men In Engineering (AWE), Middle School Students Pre-Activity Surveys and Immediate Post-Activity Surveys for Middle School-Aged Participants – Science and Engineering (2009); and
- Enthusiasm for Science Scale, Excited, Engaged and Interested Science Learner Survey (2011), Noyce Foundation.

Baseline Survey

The baseline surveys were sent to the 11 camps included in the evaluation prior to the camp start date. The study team coordinated with the designated camp evaluation leads to ensure that survey administration procedures were understood and followed at each camp. Camps administered the survey in classrooms on the first day of camp and then returned the surveys in bulk to DataStar within one week of camp end date. Next, DataStar entered the student survey data into an electronic data file. In total, 1,045 baseline surveys were collected from students with parent consent, resulting in an 81% response rate (see Exhibit 3.2).

Exhibit 3.2: Student Baseline Survey Response Rate

Total 6th-9th Grade Students Participating at Study Camps	Total Number of Students with a Baseline Survey and Parent Consent[a]	Response Rate
1,298	1,045	81%

[a] See Appendix D for details on the parent consent process.

Follow-Up Survey

The follow-up student surveys were administered to SoI participants between October and December 2013, after students had returned to school. In order to estimate change in student interest in science and participation in science activities, the follow-up survey included many of the same questions asked on the baseline survey. In addition, the follow-up survey included three open-ended questions that asked about students' impressions of their SoI experience (see Appendix C for the survey questionnaire).

Since the camps were no longer in session and instead students were attending multiple schools and enrolled across various classrooms, the surveys were mailed to students' home addresses. The evaluation team conducted follow-up activities to increase survey response rates, including mailing a reminder postcard after the initial survey was sent, emailing reminders, emailing a link to the online version of the survey, and mailing another copy of the survey to non-responders (see Appendix D for additional details about the tracking and reminder activities). In addition, up to three phone calls were made to encourage non-responders to complete their surveys and acquire any updated contact information.

For returned surveys, DataStar entered the student survey data into an electronic datafile. Open-ended responses were first entered verbatim and then coded into categories that describe the type of response that was provided. In total, 636 follow-up surveys were collected from students with parent consent, resulting in a 49% response rate (see Exhibit 3.3).

Exhibit 3.3: Student Follow-Up Survey Response Rate

Total 6th-9th Grade Students Participating at Study Camps	Total Number of Students with a Follow-Up Survey and Parent Consent[a]	Response Rate
1,298	636	49%

[a] Of the 1,045 students who submitted a baseline survey and have parent consent 605 also submitted a follow-up survey. Therefore, the follow-up survey response rate conditional on having a baseline survey is 58%.

3.3.3 The Common Instrument Validation (CIV) Dataset

The Common Instrument Validation (CIV) dataset, provided by the PEAR at Harvard University for the Noyce Foundation, provided national data for benchmarking purposes. The data were collected from 6th to 9th grade students involved in informal STEM programs across the United States during 2012 and 2013 and included a variety of questions about student interest and engagement in science. The validation dataset is national in that it was drawn from programs administered across the nation; it is not necessarily nationally representative because the sample of programs was not randomly sampled from all programs in the U.S. Also, because the survey administration procedures varied across the informal science programs included in the dataset it is not possible to link individual students between baseline and follow-up administrations. The dataset provides a cross-sectional data on a sample of middle school students participating in out-of-school STEM programs from across the country at two time points. The dataset includes the question items that make up the Enthusiasm for Science scale as well as other questions from the 2005 and 2009 NAEP - Science assessments. The CIV data provide benchmark data to compare the SoI student data at baseline and follow-up.

3.3.4 Camp Site Visit Observations

To gather data on the quality of SoI programs, pairs of study team members conducted site visits to observe activities at eight SoI camp sessions from across the Awardees and Centers included in the study. Camps were selected based on logistical considerations such as when and where the camps were offered and recommendations from SoI leaders to include, for example, demographic and geographic diversity (as described above in section 3.2). Data were collected by certified observers using the Dimensions of Success (DoS) observation tool.[29] The DoS is an observation tool that focuses on 12 dimensions of quality in STEM out-of-school programs (Exhibit 3.4), which are grouped into four broader domains. (Appendix E contains details on the 12 dimensions.)

Exhibit 3.4: The Four Domains and Twelve Dimensions of the DoS

Domain	Dimension
Features of the learning environment—that make the environment suitable for STEM programming	1. Organization 2. Materials 3. Space Utilization
Activity engagement—looking at how the activity engages students	4. Participation 5. Purposeful Activities 6. Engagement with STEM
STEM knowledge and practices—particularly the extent they help students understand STEM concepts, make connections, and participate in practices of STEM professionals	7. STEM Content Learning 8. Inquiry 9. Reflection
Youth development in STEM—looking at whether: interactions encourage student participation, activities are relevant to students' lives and experiences, and students are encouraged to voice their ideas and opinions and make meaningful choices.	10. Relationships 11. Relevance 12. Youth Voice

Consistent with the guidelines for DoS administration, at each camp visited two classrooms were observed twice, once on each day of the two day visits, for a total of four observations per camp. During each of the observations, the 12 dimensions were rated using a four-level rubric representing increasing quality, where a rating of "1" indicates that evidence is absent, "2" indicates there is inconsistent

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29 To become certified observers, nine study team members participated in a two-day DoS training webinar and each conducted two practices observations.

evidence, “3” indicates there is reasonable evidence, and “4” indicates there is compelling evidence.[30] According to the developers of the DoS, ratings of three or four on a dimension are desirable.

3.3.5 Focus Groups with Teachers

SoI teachers were invited to participate in one-hour focus groups during the site visit in order to gather in-depth information about program implementation. The semi-structured interviews asked teachers about student activities, curriculum planning and preparation, successful and challenging aspects of the curriculum, resource availability and utilization, and professional development experiences. Teachers’ experiences with the student activities conducted are summarized in this report. To guide study team members in the facilitation of the teacher focus groups, a protocol was developed and used (Appendix F). One focus group was conducted at each of the eight camps visited. In total, 45 teachers participated in the focus groups conducted across the camps.

3.3.6 NASA Performance Data

Performance data, collected by NASA through project activity reporting forms and quarterly reports, allows NASA to monitor each SoI project. NASA uses several different types of reporting forms to collect performance data. For example, the Implementation Schedule, a planning document, collects information on SoI content type such as earth and space science, robotics, aeronautics or rocketry. The Activity Form, a post-implementation document, collects information on the number of participating students and educators, the gender and racial/ethnic backgrounds of students, and information on any partners or collaborators. The Family Involvement Form describes the number of parent, student, and other attendees, as well as the type of family event held and a brief description. The Educator Content Training Schedule, a planning document, captures the training schedule, the number of hours of each training event, the SoI content for each training event, and the target number of certified teachers, pre-service teachers and informal educators for each training event. The Recruitment Event form reports on the number of student, parent, educator, and other participants, as well as a description of the recruitment event. Note that recruitment data is collected only from National Awardees, as Centers do not have a recruitment requirement.

NASA provided the study team with the performance data from all 690 camps that implemented SoI during the summer FY2013 activities, including the number of students in total and by grade, gender, race/ethnicity, and free- and reduced-price lunch eligibility; hours of exposure to SoI content; number of educators and educator type; average classroom student to educator ratio; and partner/collaborator type. These data were analyzed to describe the SoI project as a whole in summer 2013 and to identify variation in outcomes across study camp characteristics.

3.3.7 Camp Registration Data

Study team site liaisons coordinated with the Awardee/Center or camp evaluation leads to obtain registration information, including parent and student names and contact information. Camp evaluation leads were required to submit registration data to the study team within one week of the camp’s end date. These data, in conjunction with the student attendance sheets, identified the study sample and enabled the study team to contact parents and students in the fall of 2013 during the follow-up period.

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30 Shah, A., Wylie, C., Gitomer, D., Noam, G. (2013). *Technical Report for Dimensions of Success: An Observation Tool for STEM Programming in Out-of-School Time*. Released by Program in Education, Afterschool, and Resiliency (PEAR) at Harvard University and McLean Hospital.

3.4 Analysis

Qualitative and quantitative data analyses were conducted to investigate questions related to student outcomes.

3.4.1 Qualitative Data Analysis

Members of the study team reviewed the open-ended follow-up survey responses. After closely reading these answers, the team discussed the themes that emerged, and through consensus, crafted a coding scheme to apply to the open-ended follow-up survey responses. Open-ended comments were coded using this inductive coding scheme and summarized descriptively.

3.4.2 Quantitative Data Analysis

Descriptive Analyses

The study team cleaned and analyzed parent and student survey data, the NASA performance data, and the DoS data to generate descriptive statistics (i.e. counts, ranges, frequencies, means, and standard deviations) about key predictor and outcome variables.

Descriptive statistics of parent survey items include student demographics, parent backgrounds, and parents' motivations for registering their children for SoI. Descriptive statistics of student survey items focus on variables such as student motivation, educational aspirations, and interest and engagement in STEM. Additionally, a comparative analysis describes the differences between SoI students' interest in STEM and that of a national benchmarking sample of students from the CIV dataset. Descriptive statistics of performance data include student demographics, educator characteristics, and information about partners/collaborators across all Awardees/Centers. Descriptive statistics for DoS data include results of the four different domains and their dimensions.

Means and standard deviations are used to describe central tendency and variation for survey items using continuous scales. Frequency distributions and percentages are used to summarize answers given on categorical scales. Because the universe of students and parents within the selected camps were administered surveys, there is no need for calculation of standard errors or confidence intervals as these are statistical concepts that apply to sample data. Additionally, the high response rates to the parent and baseline student surveys and similarities between the baseline and follow-up student survey respondents made it unnecessary to make any adjustments for nonrespondents (see the Handling Nonresponse section on page 18 and Appendix G for a comparison of the survey respondents to nonresponders).

Change Over Time Analyses

The evaluation investigated change over time by comparing baseline with follow-up survey results. The baseline and follow-up surveys contained 35 items designed to measure the key outcomes of STEM interest and enthusiasm.[31] Given the number of items, four constructs were created measuring different aspects of STEM interest: the Enthusiasm for Science scale (measuring interest and engagement in science), interest in design and hands-on STEM activities, interest in out-of-school STEM activities, and general interest in science at baseline and follow-up. Of the four constructs, the Enthusiasm for Science

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[31] The surveys included a total of 37 items that could have been combined to create these measures; however, factor analyses determined that two of the items were not sufficiently related to any of the other items to be included in the newly created constructs. These items were, "I would like to have a science or computer job in the future" and "I take science only because it will help me in the future." These items were excluded from analyses and reporting.

scale is an existing scale developed by PEAR at Harvard University (see Section 3.3.3 for additional details), and three were created by the evaluation team using factor analysis[32] to group together items that were similarly themed. Appendix H presents the Cronbach's alphas[33] at baseline and follow-up for each of the constructs, and provides additional details about how each construct was created.

The outcome measures included in all of the analyses were change scores for each of the four constructs between baseline (pre) and follow-up (post). These change scores (post-pre) were calculated for each of the four constructs and assessed using two-level hierarchical linear models (HLM). HLM is appropriate for this research question because students are nested within camps.[34] The multilevel modeling also parses the variance among students (level 1) and camps (level 2) to produce both more precise point estimates of the intervention change and accurate standard errors (Raudenbush and Bryk, 2002). Models differed slightly depending on the research question; below, details of these models are presented.

Assessing Overall Changes in Self-Reported STEM Interest

The Level-1 model (student):

$$Y_{ij} = \beta_{0j} + \varepsilon_{ij}$$

where,

- Y_{ij} is the change score (post-pre) of an outcome measure (e.g., Enthusiasm for Science scale) for the i^{th} student in the j^{th} camp;
- β_{0j} is the mean value of the change score of the outcome measure for students in camp j;
- ε_{ij} is the student-level residual or error term of the i^{th} student in the j^{th} camp. The assumed distribution of these residuals is normal, with mean = 0, and variance $= \sigma^2$.

The Level-2 model (camp):

$$\beta_{0j} = \gamma_{00} + \alpha_{0j}$$

where:

- γ_{00} is the mean value of the change score of the outcome measure across camps;
- α_{0j} is the error term for the j^{th} camp. The distribution is assumed to be independent of ε_{ij} and normal, with a mean of zero and variance of τ^2.

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32 Factor analysis is a statistical data reduction tool that allows us to describe many variables using a few factors. For example, conducting a factor analysis on 10 items related to science may indicate that it is appropriate to group together the five items that focus on science coursework and the five items that focus on science leisure activities.

33 Cronbach's alpha (α) assesses reliability of a rating comprising individual items combined to create a measure the construct. Typically, a Cronbach's alpha above 0.7 indicates that the scale is sufficiently reliable.

34 We nested models at the camp, rather than Awardee/Center level because some Awardees/Centers had camps that were distributed across several states, suggesting that we could more accurately capture variation using a camp level nesting. Sensitivity analyses that nested at the Awardee/Center level supported this decision and indicated that the variance explained (intraclass correlation, or, ICC) by this level was small and non-significant for each outcome. Specifically, the ICCs (and the p-values associated with the Awardee/Center-level variance) for each outcome were: 0.013 (p = 0.102) for the Enthusiasm for Science scale, 0.007 (p = 0.189) for the interest in design and hands-on activities scale, 0.013 (p = 0.101) for the interest in out-of-school stem activities scale, and 0.010 (p = 0.174) for the general interest in science scale. When multiplied by 100, the ICCs reflect the percentage of outcome variance explained by the nesting level. Thus, for example, only 1.3 percent of the variance in the change from pre to post in Enthusiasm for Science scale was explained by the Awardee/Center.

Assessing Changes in Self-Reported STEM Interest by Student Subgroup

Models to assess change in self-reported STEM interest by student subgroup included student-level covariates of interest (e.g., gender, race/ethnicity) in the Level-1 model and a Level-2 model that accounted for students nested within camps.

The Level-1 model (student):

$$Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + \varepsilon_{ij}$$

where:

$Y_{ij:}$ is the change score (post-pre) of an outcome measure (e.g., Enthusiasm for Science scale) for the i[th] student in the j[th] camp;

X_{ij} is the characteristic of interest for the i[th] student in the j[th] camp that is hypothesized to be associated with the change score of the outcome of interest (e.g., gender coded as 1=female and 0=male);

β_{0j} is the mean value of the change score of the outcome measure for the reference group of the student characteristic (e.g. males) in camp j;

β_{1j} is the difference between the mean value of the change score of the outcome measure between the categories of the student-level characteristic of interest (e.g. the difference of the change score of the outcome between females and males);

ε_{ij} is the student-level residual or error term of the i^{th} student in the j^{th} camp. The assumed distribution of these residuals is normal, with mean = 0, and variance $= \sigma^2$.

The Level-2 model (camp):

$$\beta_{0j} = \gamma_{00} + \alpha_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

where:

γ_{00} is the mean value of the change score of the outcome measure across camps in the reference group of the characteristic of interest;

γ_{10} is the mean difference in the change score of the outcome between the groups of the characteristic of interest across camps;

α_{0j} is the error term for the j[th] camp. The distribution is assumed to be independent of ε_{ij} and normal, with a mean of zero and variance of τ^2.

Assessing Changes in Self-Reported STEM Interest by Camp Characteristics and Program Quality

To assess changes in self-reported STEM interest by camp characteristics and program quality (DoS measures), we used a model similar to that outlined above, with the exception that camp-level characteristics from the NASA Performance Data and measures of program quality were merged to the student-level data and added to the Level-2 model.

The Level-1 model (student):

$$Y_{ij} = \beta_{0j} + \varepsilon_{ij}$$

where:

- Y_{ij}: is the change score (post-pre) of an outcome measure (e.g., Enthusiasm for Science scale) for the i^{th} student in the j^{th} camp;
- β_{0j} is the mean value of the change score of the outcome measure for students in camp j;
- ε_{ij} is the student-level residual or error term of the i^{th} student in the j^{th} camp. The assumed distribution of these residuals is normal, with mean = 0, and variance = σ^2.

The Level-2 model (camp):

$$\beta_{0j} = \gamma_{00} + \gamma_{01} W_j + \alpha_{0j}$$

where:

- γ_{00} is the mean value of the change score of the outcome measure across camps in the reference group of the characteristic of interest;
- W_j is the camp characteristics or program quality measure of interest at the j^{th} camp;
- γ_{01} is the mean difference in the change score of the outcome between the camp characteristic of interest that is hypothesized to be associated with the change score of the outcome of interest;
- α_{0j} is the error term for the j^{th} camp. The distribution is assumed to be independent of ε_{ij} and normal, with a mean of zero and variance of τ^2.

Handling Nonresponse

Unit non-response may pose a problem in analyses if students who refuse to participate or leave the study have different characteristics and/or give systematically different responses to the survey (had they responded to it) than the students who complete the surveys. Poor response rates do not necessarily produce a biased estimate, as the decision to not participate or leave the study could be unrelated to survey answers. For the present study, we tested for bias that might occur when students who returned a baseline survey did not return a follow-up survey. As Appendix Exhibit G.1 indicates, among those students who responded to the baseline survey, 605, or 58 percent, responded to the follow-up survey.[35]

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[35] In addition to the checks and adjustments discussed above, the evaluation team executed a non-response follow-up (NRFU) bias study to assess whether the follow-up responses of non-responders were systematically different from those of responders and determined there was not sufficient evidence to correct the follow-up data for non-responders based on the results of the NRFU study. See Appendix G more additional details about the NRFU.

Given that the follow-up response rate was below 80 percent, the study explored the potential bias in the estimates if the responders to follow-up survey were significantly different from those who did not respond to the follow-up survey (see Appendix G for a full discussion of missing and non-response bias). A series of checks were run to estimate potential bias between responders and non-responders. Students who provided follow-up and baseline surveys were considered responders and students who provided only baseline surveys were non-responders for the purpose of these checks. The first check was to assess whether there were any significant differences on the key background variables that could be used in a propensity model to determine weights to correct bias, if detected. Exhibit G.2 in Appendix G compares the background characteristics of responders to those of non-responders and indicates that none of the differences were large enough to be practically meaningful and did not necessitate weighting in the models.

While the responders and non-responders were similar in terms of their demographic characteristics, the second check demonstrated that they did differ at baseline on the outcomes of interest. Students who did not return follow-up surveys (non-responders) had lower baseline scores on the four outcomes constructs than those that did return follow-up surveys. Thus, it is likely that if non-responders had returned a follow-up survey, their scores at follow-up would also have been lower than responders' scores. Therefore the missing data is unlikely to be "missing completely at random" (MCAR) and nonimputation was likely to bias the results (Rubin 1976; Rubin 1987). Thus the follow-up scores were imputed using single stochastic imputation for those students with baseline surveys but no follow-up survey.

As expected, after imputation, averages at follow-up for each construct were smaller than those calculated solely on students who responded to the follow-up survey (see Exhibit G.3), suggesting that the results of the models run on the imputed sample are more likely, than the results run on the non-imputed sample, to better estimate the true change between baseline and follow-up. Therefore, the results presented in this report are based on models in which outcome measures were imputed for between 431 to 439 follow-up survey non-responders, depending upon the outcome.[36]

3.5 Limitations

This evaluation and its data collection contribute valuable information about the SoI project. Nonetheless, it is not without its limitations. In particular, the evaluation is limited in its ability to generalize findings to camps outside of those in the study sample. The camps that participated in the FY2013 evaluation were purposively selected to ensure the evaluation would improve NASA's understanding about the successes and challenges, and, ultimately, the replicability of a promising SoI program model. The evaluation examined the stand-alone model implemented at camps with at least 75 students. Because the sample of camps was purposively selected, they might have characteristics that are systematically different than the full population of camps and even the population of camps that implement the stand-alone model. Therefore, it cannot be assumed that the sample is representative of all SoI camps, or that it is representative of all stand-alone SoI camps. The focus on understanding SoI in camps implementing the stand-alone model at a relatively large scale means that the FY2013 evaluation cannot make statements about the SoI project as a whole or about all stand-alone camps.

[36] The outcome measures of interest are measures of change in science interest and engagement. Estimates of change were calculated for all 1,045 students that completed a baseline survey with parent consent, including the 605 students that also completed a follow-up survey and 431 to 439 students for whom follow-up data were imputed.

Variation in the reference periods included in the questions about student participation in extracurricular science activities limited inferences about change in participation to descriptive, cross-sectional reports, thus no statistical tests were performed. The reference period cited on the baseline survey was the entire 2012-2013 school year whereas the reference period for the corresponding question on the follow-up survey asked students only about activities participated in during the fall of the 2013-2014 school year. Therefore, the timing of the survey administrations (after an entire school year and at the beginning of the subsequent year) and the effort to draw on existing questions constrain the interpretation of change in activity participation.

In addition, the one-group, extended pre/post evaluation design does not allow for causal inferences about the impacts of SoI on students. Instead, the evaluation measures change in outcomes of interest for one group of self-selecting students, where post-participation outcomes are measured after an extended period of up to three months (follow-up surveys were administered fall 2013), during which students have the opportunity for exposure to other STEM programs and content that is unrelated to SoI participation. Nonetheless, the investigation of students' outcomes in the fall is of interest because existing research documents a prevailing decline in attitudes toward science as children progress through schooling. Importantly, a growing number of studies have shown that children's interest in and attitudes toward science decline from the point of entry to secondary school.[37]

[37] For example, Breakwell. G. M. & Beardsell, S. 1992. Gender, parental and peer influences upon science attitudes and activities. *Public Understanding of Science,* 1, 183–197. Dohert, J., & Dawe, J. 1988. The relationship between development maturity and attitude to school science. *Educational Studies,* 11, 93–107. Harvey and Ed Hadden, R. A., & Johnstone, A. H. 1983. Secondary school pupils' attitudes to science: the year of erosion. *European Journal of Science Education,* 5, 309–318. Yager, R. E., & Penick, J. E. 1986. Perception of four age groups toward science classes, teachers, and the value of science. *Science and Education,* 70, 355–363.

4. Findings

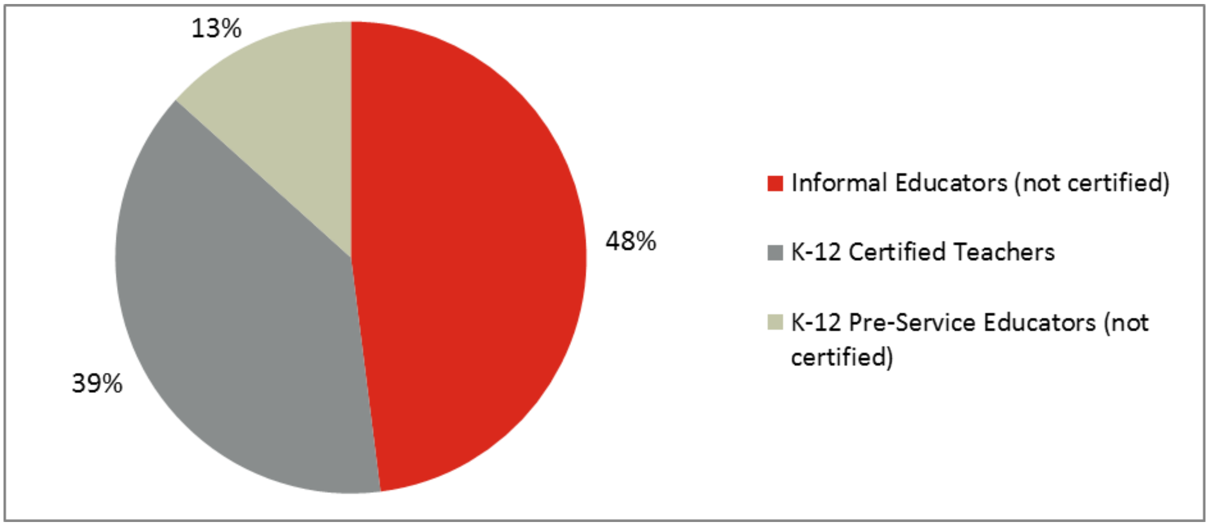
In this chapter, we first provide an overview of the scope of all SoI camps operating in 2013. Then we focus on the evaluation sample and present findings relevant to our investigation of outcomes of interest in the stand-alone program model, drawing on previously reported findings, as well as data collected through parent and student surveys, the CIV dataset, registration data from camps, and camp site visit observations.

Key findings from the implementation study[38] are discussed below because they provide contextual information to help understand student outcomes, as well as identify potential sources of variation that might explain differences in student outcomes. The first sections present background characteristics of students, followed by a discussion of experiences in the camps from the perspective of observers, teachers and students. Finally the student outcomes of interest are explored overall, for specific subgroups, and as relative to a national benchmark.

4.1 SoI in 2013

Information from the performance data system provides an overview of the scope and reach of SoI in 2013 across all funded awardees and centers. Across the 690 SoI camps that operated during the summer of 2013, certified teachers comprised just over one-third of the educators at SoI camps, while almost one-half of the 2013 SoI educators were informal educators (see Exhibit 4.1).

Exhibit 4.1: SoI Educators



n = 690 camps and 4,407 educators
Source: NASA Summer of Innovation 2013 Performance Data

[38] Martinez, A., Linkow, T., Brooke, N., DeLisi, J., & Levy, A. J. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Implementation Report.* Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA. Available http://www.nasa.gov/offices/education/performance/index.html

Based on data reported to NASA by camps, the SoI camps served 39,223 students during the summer of 2013. Participating students ranged from rising 4th graders to rising 9th graders, with higher proportions of students in the lower grades.

Exhibit 4.2: Student Participant Characteristics

Student Characteristics	%
Grade	
4th	22.7
5th	22.0
6th	20.2
7th	16.0
8th	12.2
9th	6.9
Gender	
Female	48.4
Male	51.6
Ethnicity	
Hispanic	34.2
Non-Hispanic	65.8
Race	
White	29.5
Black	35.0
Asian	3.8
American Indian or Alaskan Native	2.4
Native Hawaiian or Pacific Islander	0.3
Not Reported	29.0

n=39,223
Source: NASA Summer of Innovation 2013 Performance Data

The camps reported that, on average, almost all of their students (93 percent) attended at least half of the session days at their camp, and, on average, the educator-to-student ratio was 1 to 13.

Exhibit 4.3: Selected Camp Characteristics

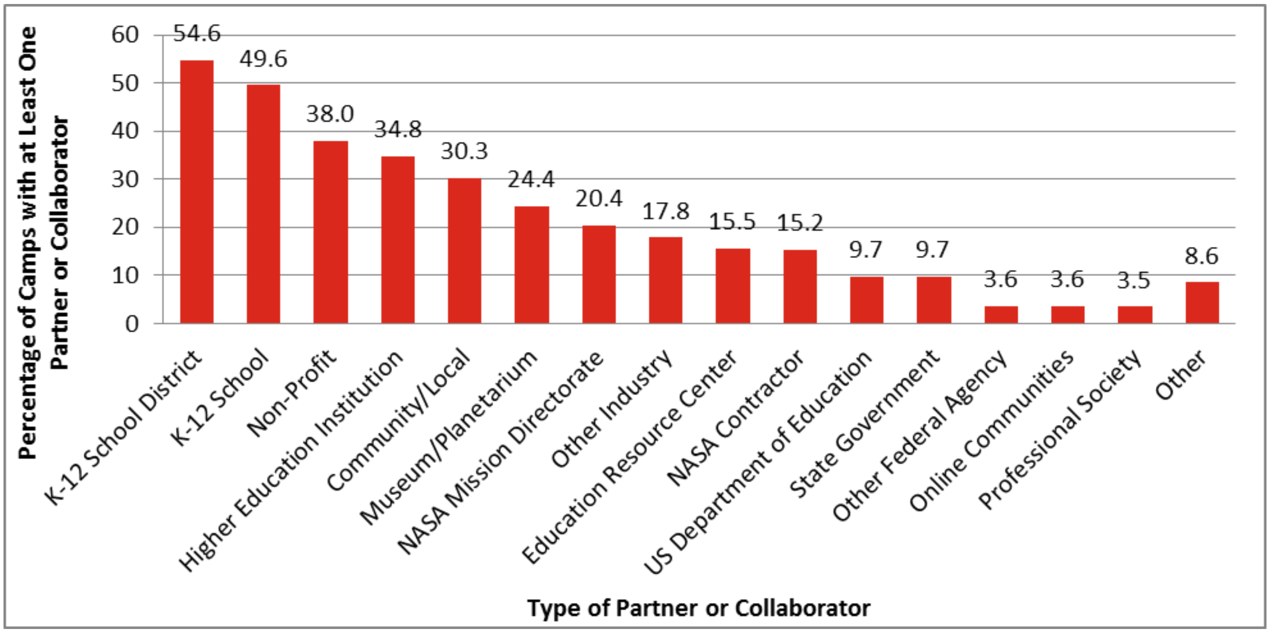
	Number of Camps	Mean	Standard Deviation
Percent of students attending half or more of camp session	688	92.8	14.1
Number of students per educator	690	13	7.1

Notes: Each camp reported the percent of students attending half or more of the camp session. For educator-student ratios camps either reported the average educator-student ratio across their classes or the ratio of total educators to total students.

Source: NASA Summer of Innovation 2013 Performance Data

Awardees/Centers partnered with a range of formal and informal organizations (Exhibit 4.4). Most commonly, partnerships were established with school districts or individual schools.

Exhibit 4.4: Types of SoI Camp Partners



n =583 camps
Source: NASA Summer of Innovation 2013 Performance Data

The remainder of the findings pertain specifically to the evaluation sites.

4.2 Student Characteristics

Parent surveys, collected along with camp registration materials, provide information on the background characteristics of SoI students and parents in the analytic sample.[39] Additional insight into the characteristics of SoI students can be gleaned from their survey responses to questions about why they signed up for SoI, their educational expectations, previous experiences with science in school and their participation in science activities.

4.2.1 Student Demographics

By design, the grade range of the students in the evaluation was limited to students entering 6th through 9th grade in fall 2013 (Exhibit 4.5). Fewer than 10 percent of these students were entering as 9th graders in fall 2013. At the study camps, there were slightly more male students than female students participating, and the majority (71 percent) of SoI students participating were from an ethnic or racial group underrepresented in STEM (i.e., Hispanic, Black, American Indian or Alaska Native, and Native Hawaiian/Pacific Islander). About one-third of students (34 percent) reported previously participating in SoI, but for over one-half of the students (55 percent), summer 2013 was their first time participating in SoI.

Information on parental education indicates that just over one-third (38 percent) of SoI students' parents at the study camps had a high school education or less. Of the parents with an Associate's degree or

[39] Parent surveys were received from a total of 1,121 parents but only 1,045 students completed baseline surveys and have parent consent. The data presented in this chapter are based on the 1,045 parent surveys for the students included in the analytic sample (students with baseline surveys and parental consent).

higher, about one-third (36 percent) reported that their degree was in a STEM field and two-fifths (40 percent) reported working in a STEM field.

Exhibit 4.5: Student Background Characteristics

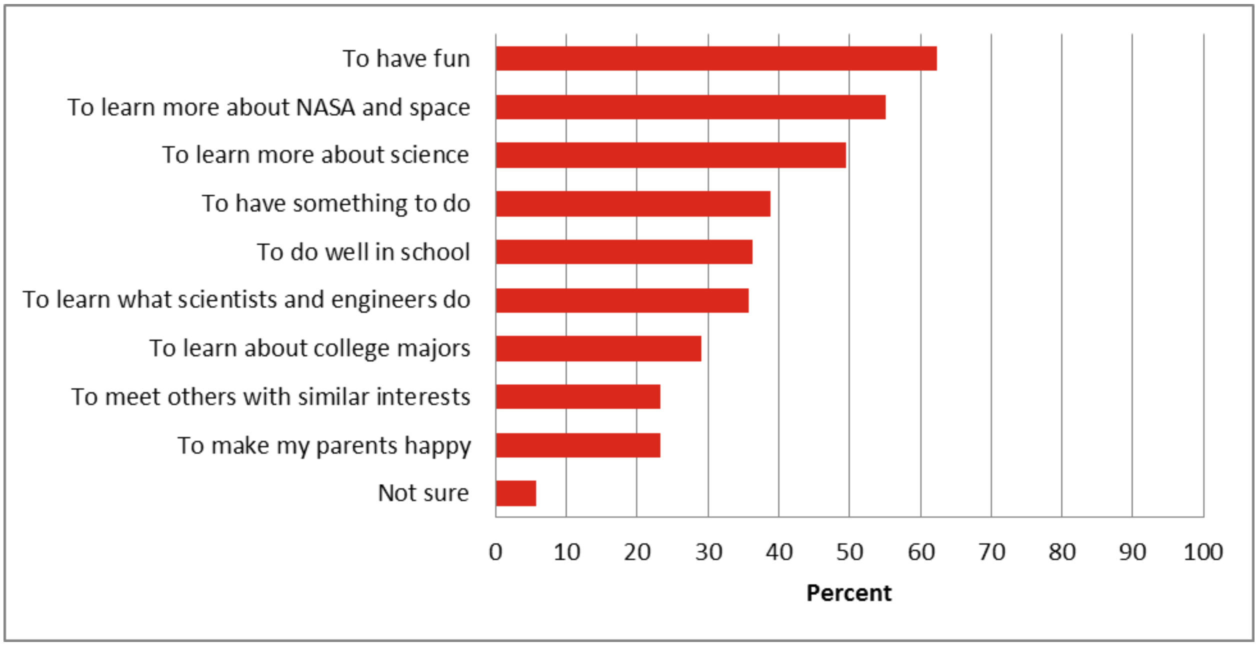
	%
Rising Grade Level (n = 1045)	
6th Grade	39.2
7th Grade	29.1
8th Grade	22.5
9th Grade	9.2
Gender (n = 1037)	
Female	43.4
Male	56.6
Ethnicity (n = 1022)	
Hispanic or Latino/Latina	32.3
Not Hispanic or Latino/Latina	67.7
Race (n = 1034)[a]	
American Indian or Alaska Native	1.6
Asian	9.8
Black or African American	38.4
Native Hawaiian or other Pacific Islander	0.1
White	43.9
Underrepresented in STEM (n = 1020)[b]	
Yes	70.6
No	29.4
Previously Participated in SoI (n=1043)	
Yes	34.1
No	55.2
Don't know	10.6
Parental Highest Level of Education Completed (n = 985)	
Less than high school	8.7
High school diploma or GED	29.0
Associate's degree	13.3
Bachelor's degree	27.9
Graduate degree	21.0
Parent Degree in STEM Field (n = 603)[c]	
Yes	36.2
No	63.8
Parent Works in STEM Occupation (n = 595)[c]	
Yes	40.0
No	60.0

Notes:
[a]Responses do not sum to 100 because camps did not report racial data for all students.
[b]Includes students who reported ethnicity as Hispanic or Latino/Latina or race as American Indian or Alaska Native, or Black or African American. Asian students are not considered underrepresented in STEM.
[c]These questions were only asked to parents who indicated they completed an Associate's degree or higher.
Source: Summer of Innovation 2013 Student Baseline Survey; Summer of Innovation 2013 Parent Survey; Camp Rosters.

4.2.2 Student Opinions, Expectations, and Experiences

Student responses to questions on the baseline survey provide a more complete picture of their characteristics. Students most often reported a reason they signed up for SoI was to have fun (see Exhibit 4.6). However, learning was also commonly cited as a reason for participating; the second and third most common reasons given were to learn more about NASA and space and to learn about science. Less than one-quarter of the students reported signing up for SoI to make their parents happy.

Exhibit 4.6: Student Reports of Their Reasons for Participation in SoI



n= 1042.

Note: Percentages do not sum to 100, as students could select multiple responses.

Source: Summer of Innovation 2013 Student Baseline Survey

Over one-half of the responding students (56 percent) expressed interest in completing a graduate degree. Exhibit 4.7 shows that two-thirds of the respondents (67 percent) expect to attain a bachelor's degree or higher, with most of those students expecting to go on to complete a graduate degree. Given that in 2009, only 10 percent of adults in the U.S. held a graduate degree (NCES, 2011); the SoI students appear to have high educational motivations.

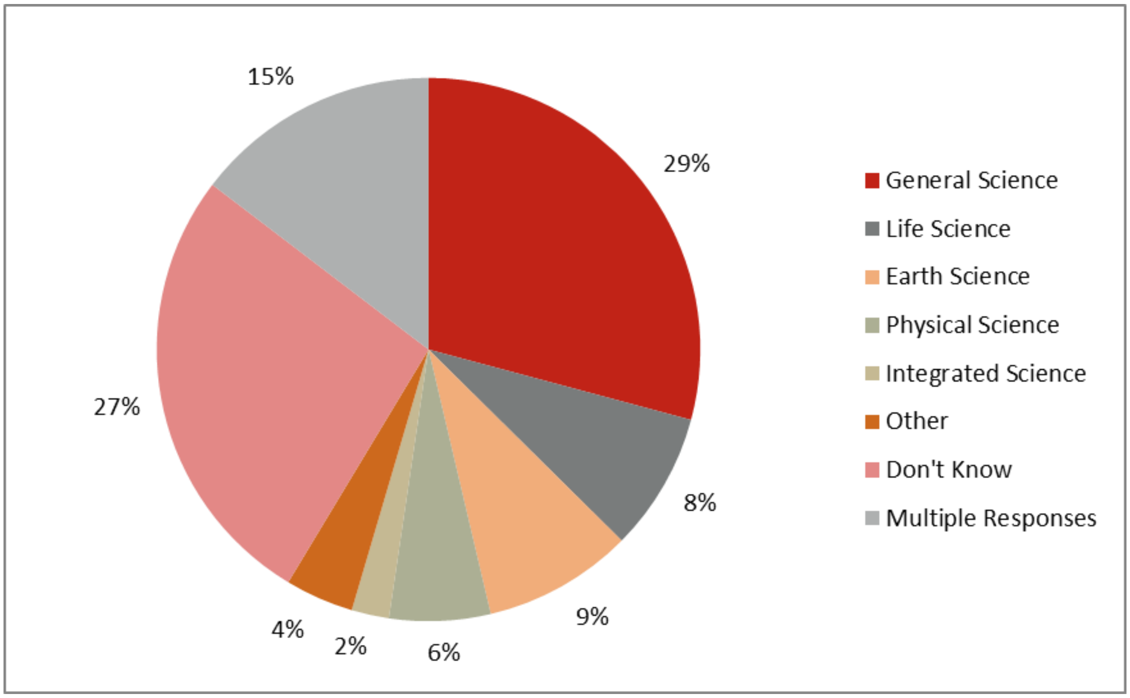
Exhibit 4.7: Student Expectations of Educational Achievement

	%
As things stand now, how far in school do you think you will get? (n = 1042)	
High School or Less	5.7
Associate's College	2.3
Bachelor's Degree	10.8
Graduate Degree	56.0
Don't Know	25.3

Source: Summer of Innovation 2013 Student Baseline Survey

Students also reported information regarding the last science class they took in school. Exhibit 4.8 shows that 29 percent of the students reported taking a general science class last year, another 27 percent did not know what science class they took, and 15 percent reported taking multiple classes. These results are likely due to the fact that most of the responding students were in the lower middle school grades where students often take general science that cover multiple science topics and students typically have no choice regarding their science classes. In the cases where students did report a specific science class, earth science and life science were most commonly cited (nine percent and eight percent of students, respectively).

Exhibit 4.8: Most Recent Science Class



n= 1032

Source: Summer of Innovation 2013 Student Baseline Survey

Exhibit 4.9 summarizes students' opinions of their previous science class, and demonstrates that students had generally positive attitudes. Ninety percent of students reported that they often or sometimes enjoyed their last science class, 83 percent reported never or rarely thinking the class was a waste of their time, and 70 percent said that they were rarely or never bored in their last science class.

Exhibit 4.9: Students' Opinions of Last Year's Science Class

	%			
	Never	Rarely	Sometimes	Often
I enjoyed this class very much	2.8	7.4	39.1	50.6
I thought this class was a waste of my time[a]	61.8	21.5	12.7	4.0
I thought this class was boring[a]	40.4	29.7	22.3	7.7

Notes:

[a] Because these statements are negatively worded, the responses of never and rarely reflect positive opinions of students' last science classes.

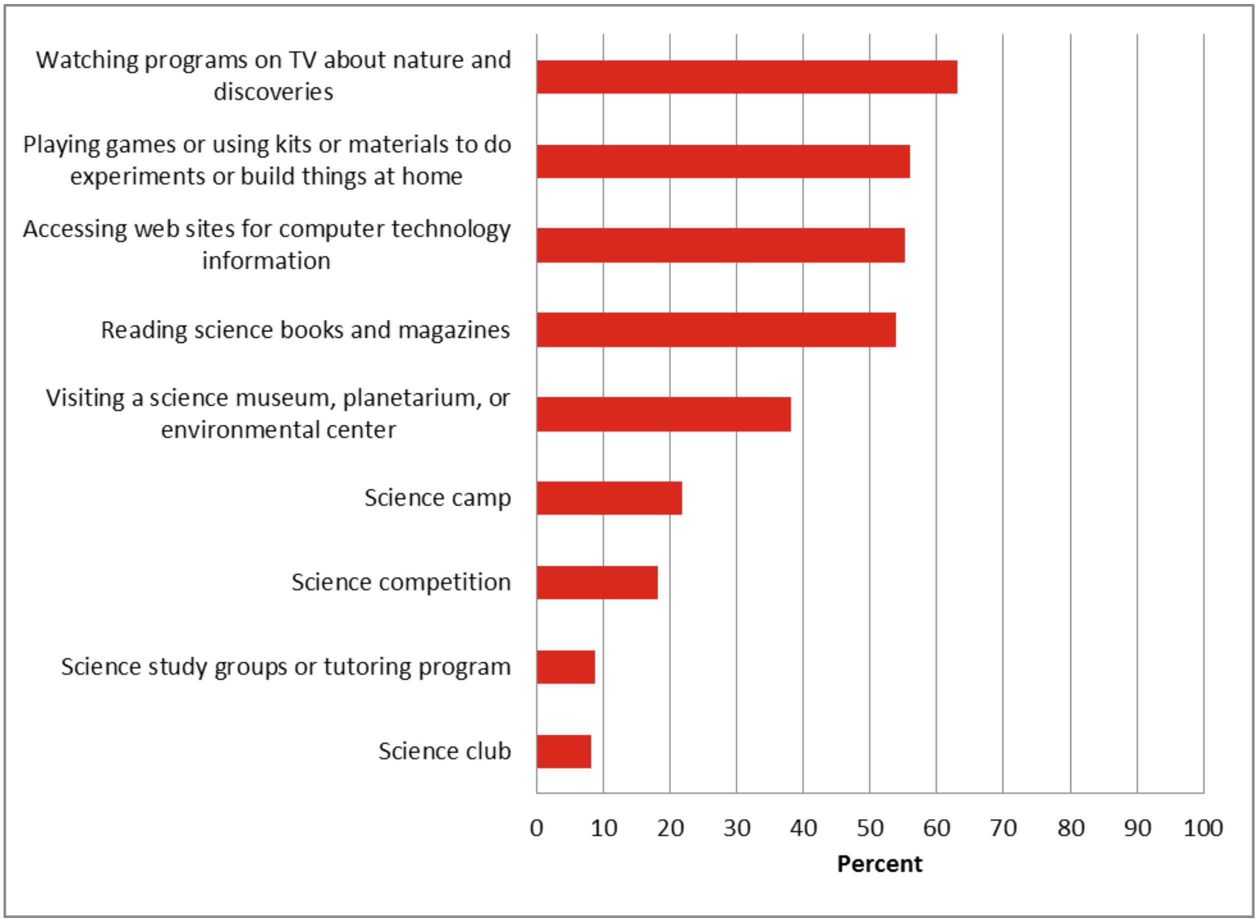
n = 1016 to 1023

Source: Summer of Innovation 2013 Student Baseline Survey

In addition to their generally high opinions of in-school science classes, Exhibit 4.10 shows that students reported previous participation in various out-of-school time science activities. Over half of students reported watching science-related television programs; playing with science games, kits, or experiments at home; accessing websites for computer technology information; and reading science books and magazines at least once over the course of the previous school year. Fewer students reported visiting science museums, planetariums, or environmental centers.

While the majority of responding students reported participating in various out-of-school *leisure* activities, few students reported participating in *organized* science activities such as a science camp, science competition, science club, or science study group/tutoring program during the previous school year (Exhibit 4.10). Fewer than ten percent of students reported participating in a science club or participating in a science study group or tutoring. Students more frequently reported participating in organized out-of-school activities like science competitions and science camps, but overall less than a quarter of students reported participating in either activity (18 and 22 percent, respectively).

Exhibit 4.10: Participation in Out-of-School Science Activities



Notes: student n = 1015 to 1033; Responses do not sum to 100 because more than one response could be selected.

Source: Summer of Innovation 2013 Student Baseline Surveys.

In summary, the students at SoI study camps were from groups traditionally underrepresented in STEM, enjoyed their previous science courses, were engaged in a multitude of STEM organized activities and informal, leisure activities, and were motivated to learn about STEM topics. The students in the study were also motivated to learn in general; over half expected to complete a graduate degree.

4.3 Student Experiences with SoI

Data gathered through classroom observations, focus groups with teachers, and student responses to open-ended questions provide insight about students' SoI experiences. FY2013 SoI stand-alone camps typically consisted of NASA-themed activities that engaged students in hands-on activities related to STEM content and the engineering design process. Most camps divided students into grade-level classes, where students worked in small groups to complete design challenges or other STEM activities. Teachers reported that the hands-on nature of the activities was key to differentiating SoI activities from formal STEM school work. Camps differed in the scientific content addressed and the overall duration of the program for students.

4.3.1 Camp Characteristics

Key camp characteristics for the camps in the evaluation drawn from the performance data are presented in Exhibit 4.11.

Exhibit 4.11: Key Study Camp Characteristics

	Mean	Standard Deviation
Number of SoI content hours	30.1	0.39
Percent K-12 certified educators	77.3	34.82
Percent students attending 50%+ of camp	93.7	8.46
Number of students per educator	25	29.45

Notes: The performance data allowed for the identification of 15 individual camp-session records across the 11 camps included in the study sample. The number of individual camp-sessions exceeds the number of camps because some study camps held multiple sessions either over multiple weeks or during the morning and afternoon.

Source: NASA Summer of Innovation 2013 Performance Data

Study camps reported providing students with at least 30 hours of SoI content. On average, study camps reported that the majority of content providers (77 percent) were K-12 certified teachers and that almost all students (93 percent) attended at least half of the session days at their camp. The average reported educator-student ratio at study camps—25—was greater than the NASA required ratio of 1 to 20.

4.3.2 Observations

As previously reported in the *Implementation Report*[40] and summarized here, the site visit observations confirmed that students are receiving a generally high quality camp experience. Following the guideline that ratings of "3" or "4" represent quality on a given dimension, the majority of observed classrooms rated highly on nine of the 12 dimensions (Exhibit 4.12).

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40 Martinez, A., Linkow, T., Brooke, N., DeLisi, J., & Levy, A. J. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Implementation Report.* Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA. Available http://www.nasa.gov/offices/education/performance/index.html

Exhibit 4.12: Percent of Classroom Observations Rated 3 or 4 on the DoS

DoS Domain	Dos Dimension	%
Youth Development in STEM	Relevance	21.9
	Youth Voice	56.3
	Relationships	93.8
STEM Knowledge and Practices	Reflection	31.3
	STEM Content Learning	43.8
	Inquiry	78.1
Activity Engagement	Purposeful Activities	75.0
	Participation	71.9
	Engagement with STEM	78.1
Features of the Learning Environment	Space Utilization	68.8
	Organization	78.1
	Materials	84.4

Note: The percents represent the percentage of classroom observations with a rating of "3" or "4". For example, 21.9% of the classroom observations received a "3" or "4" on the relevance dimension, whereas 93.8% of the classroom observations received a "3" or "4" rating on the relationships dimension.

Source: Observations using Dimensions of Success observation tool.

The classrooms rated highly ("3" or "4") on:

- *Relationships* (94 percent)—the nature of the relationship between the facilitator and the students and the students with their peers, gauging from conversations and actions whether or not the interactions suggest warm, positive relationships. Based on observation and focus group data, it was clear that the relationships between students and between students and teachers were strong. Several teachers noted that students enjoyed working together and that team building and collaboration were unintended outcomes of attending SoI camps.
- *Materials* (84 percent)—the appropriateness and appeal of the materials used in the STEM learning activity. While the majority of camps observed scored on the higher end of the DoS scale, some teachers noted insufficient supplies due to budget constraints. Other teachers mentioned that having organized activity boxes ready for use with their students was very helpful and reduced their planning time.
- *Organization* (78 percent)—the availability of materials used in the activity, the facilitator's ability to adapt to changing situations, and the fluidity of transitions during the session. Qualitative data revealed that teachers and camp leaders perceived the availability of material and time resources to be among their greatest challenges. Some described their efforts to use both material and time resources efficiently, including dividing up roles among a team of teachers, and reusing supplies when possible. The high DoS ratings also indicate that teachers and camp leaders demonstrated flexibility and creativity necessary to adapt to their perceived resource challenges.
- *Engagement with STEM* (78 percent)—the extent to which students are working in a way that is both "hands-on" and "minds-on", rating both the type of activities as well as the type of learning experience. The qualitative data indicated that the hands-on nature of the activities were central to the success of the camps. The hands-on nature of activities was almost universally observed, although the minds-on engagement was less consistent.

- *Inquiry* (78 percent)—the use of activities that support STEM practices, such as making observations, asking questions, developing and using models, planning and carrying out observations, analyzing and interpreting data, engaging in argument from evidence, and sharing findings with peers. Engineering practices, which included gathering and interpreting data in order to meet a design challenge, were commonly observed activities. Data gathering and recording were other STEM practices that were often practiced as part of the activities.
- *Purposeful activities* (75 percent)—the structure of the learning activities, measuring the extent to which the students understand the goals of activities and the connections between them, as well as the amount of time spent on activities that relate to the STEM learning goals. In general teachers felt prepared and comfortable providing structure for the activities, and this was reflected in the observations. However, some teachers noted that they felt less prepared and some activities were easier to structure, especially those that had been covered in PD.
- *Participation* (72 percent)—the extent to which students are visibly and audibly participating in the activities. Students were typically engaged in the SoI classrooms. As documented in the observations and in teachers' comments, however, there were instances in which students were not engaged, and some students that required more attention to keep them engaged. Although SoI specifies a student to teacher ratio of 20 to 1, some teachers reported larger groups and corresponding challenges with implementing hands-on activities with large groups.
- *Space utilization* (69 percent)—the extent to which the physical space where the STEM activity is held is conducive to out-of-school-time STEM learning. Many of the classrooms or spaces that were used for SoI allowed for students to engage in STEM in formats that do not mirror traditional classrooms. Some of the spaces observed and described by teachers, however, were cramped or structured in a way that did not readily support STEM activities and learning.
- *Youth voice* (56 percent)—the ways in which the STEM activity allows students to use their voices and fulfill roles that offer them personal responsibility. While teachers talked about the engagement of students in hands-on activities, they less frequently expressed the importance of student choice and voice in these activities. The active role of students in assuming responsibility for activities was more prevalent in engineering design activities where students made decisions about design, testing, and redesign.

Three dimensions received low ratings across the majority of sessions observed; more than half of the sessions observed scored a "1" or "2" on these dimensions.

- *STEM content learning* (44 percent)—the support students receive to build their understanding of STEM concepts through the activities implemented. Many teachers expressed comfort with the STEM content of the lessons. Teachers noted that the PD provided them with additional content knowledge, although there were some teachers that felt somewhat unprepared for activities that were not covered in the PD. This variation across classrooms was observed as STEM content learning was strong in some classrooms and weak in others.
- *Reflection* (31 percent)—the amount of explicit reflection of STEM content during the activity, and the degree to which student reflections are deep and meaningful, supporting connection-building between concepts. Instances where explicit reflection that supported connections between concepts were not commonly observed. Where observed, teachers used probes to get students to reflect more deeply about their learning.

- *Relevance* (22 percent)—the extent to which the facilitator guides students in making connections between the STEM activities and their own lives or experiences, situating their activity in a broader context. Observers noted only a few instances where direct connections were made to the real-life significance or related experiences of the activities. Despite the low DoS ratings, teachers in the focus groups perceived students to have made connections between the activities and the work of scientists and engineers. They described creating roles among groups of students that reflected real-life teams and cited examples of students who, after participating in the design activities, expressed interest in related careers.

Observations documented high ratings on most dimensions on the DoS tool suggesting that most students enjoyed a quality learning experience in most areas. The dimensions on which lower ratings were generally received suggest that some additional attention may be needed in the extension of concepts to students' lives and the intentional engagement of students in reflection. Further, camps may need additional supports to enhance the level of STEM content learning that occurs in their classrooms

4.3.3 Teacher Reflections

Teacher comments in focus groups, analyzed to better understand SoI implementation, provide insight into students' experiences with SoI. A summary is presented here to provide context; for a more detailed discussion of teachers' perceptions please see the *Implementation Report*.[41]

Overall, teachers indicated that the activities they conducted with students were based almost exclusively on SoI curricula and materials, though occasionally there were curriculum modifications and/or outside materials introduced. Teachers cited the satellite, rocket, and volcano activities as the most popular activities among their students. Generally, they described the activities as being fun and hands-on. Moreover, teachers described their students as having more motivation and engagement precisely because of the hands-on activities. Students often wanted to take their activity projects (e.g. rockets, roller coasters, cranes) home with them, or continue working on their activities after the end of the activity.

The activities also provided opportunities for students to experiment and engage in the engineering design process. Teachers indicated that students appreciated being able to revise their designs. Teachers perceived the activities as a chance for students to engage in the type of work and cognitive application of a career scientist. Some topics were new to students, and a few teachers noted that the application or connection between the activity and real life was successfully bridged. Teachers reported that in group activities students learned to cooperate, listen, and share ideas. In addition to students' enthusiasm, engagement, and interest in careers, teachers also perceived increased content understanding and teamwork skills as student outcomes. Many teachers attributed the success of the hands-on activities to their contrast to formal school environments, where "tests" and direct instruction are prevalent. Teachers also appreciated the departure from more structured classes. Similarly, teachers enjoyed the "freedom" they had in planning the SoI activities; if an activity or topic was not working well, the teacher could simply "move on," unlike the school year where a teacher may be "stuck to a rigorous curriculum … because you are getting ready for the tests that we have."

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[41] Martinez, A., Linkow, T., Brooke, N., DeLisi, J., & Levy, A. J. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Implementation Report.* Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA. Available http://www.nasa.gov/offices/education/performance/index.html

Most teachers described organizing and structuring activities using a similar routine; they devoted a small amount of time to presenting background information and activity goals to the students—sometimes with handouts or visual information posted on a blackboard, whiteboard, or projector—and then they had the students break into groups to engage in the activity. The nature and number of the activities themselves varied depending on the teacher, camp, and the daily plan.

Most activities occurred in groups, but a few teachers occasionally had students work independently. Most teachers indicated that they allow time for groups to show and/or demonstrate the final products from their activity, with competitions being a favorite format. Students in groups were typically in the same or proximate grades, mixed gender, and sometimes included students who knew one another from their schools or district. However, some teachers made efforts to create groups of students unfamiliar with one another, and others made efforts to change groups each day, so that all students would be included and have opportunities to make new friends. Additionally, some teachers described the groups as functioning science teams; that is, each member had a specific role for the activity.

4.3.4 Students Responses

Students' responses to three open-ended questions on the follow-up survey provide additional insight into student experiences with SoI. Students' perceptions reinforced the findings from observations and teacher focus groups that SoI provides a positive summer STEM experience for students.

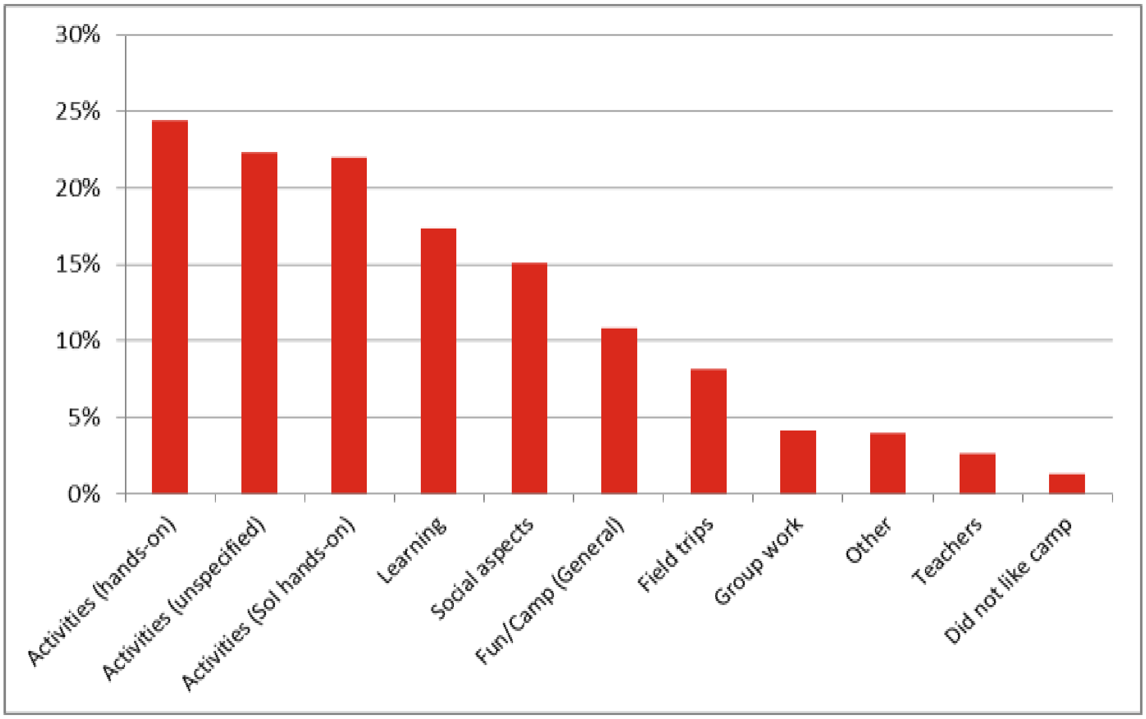
Responses were analyzed individually for each question through use of an inductive coding scheme. Statements that contained more than one idea were double-coded into two or more appropriate categories. Overall, student responses were brief and often vague, ranging from one or a few words (e.g., "Everything," "It was fun," or "I liked it") to more specific and sometimes more lengthy single sentences ("I liked the experiments"). The shorter and vague responses provided limited information, but the more specific responses provided a slightly more nuanced picture of students' experiences.

What students liked best about SoI

Students commented on different aspects of the SoI program that they liked best, ranging from general comments (e.g. "It was fun" or "everything") to more specific (e.g. "I liked meeting new friends"); responses were coded into 11 categories (Exhibit 4.13). Overall, most students indicated that they enjoyed the activities the best. Nearly one quarter of students (24 percent) liked the hands-on nature of the activities, with one responding, "It was fun because I was able to be hands on and build things", while others mentioned liking SoI specific activities (22 percent) such as "the egg drop" or "the soda rocket experiments." Other responses described the field trips as an enjoyable aspect of the camps (8 percent), with statements such as "It was cool because we went to NASA."

Students also commented on other aspects of their SoI experiences, such as their enjoyment in learning science and spending time with their friends. Seventeen percent of students stated that they liked learning best, with statements such as "I learned about a lot of new and interesting topics" and "I like that I got to do different stuff and I was able to learn science in a different way." The social aspect of camp was also mentioned (15 percent), as students' described their friends and "all the cool people I met." A small portion of students (11 percent) provided very general responses that indicated that camp was "fun" and they liked "everything" about it. A smaller percentage of students described group work (4 percent) or teachers (3 percent), while very few (1 percent) indicated that they did not like camp at all.

Exhibit 4.13: What Students Liked Best about SoI



Notes: n = 610
Percentages sum to more than 100 because responses could be coded into multiple categories.
Source: Summer of Innovation 2013 Student Follow-up Survey

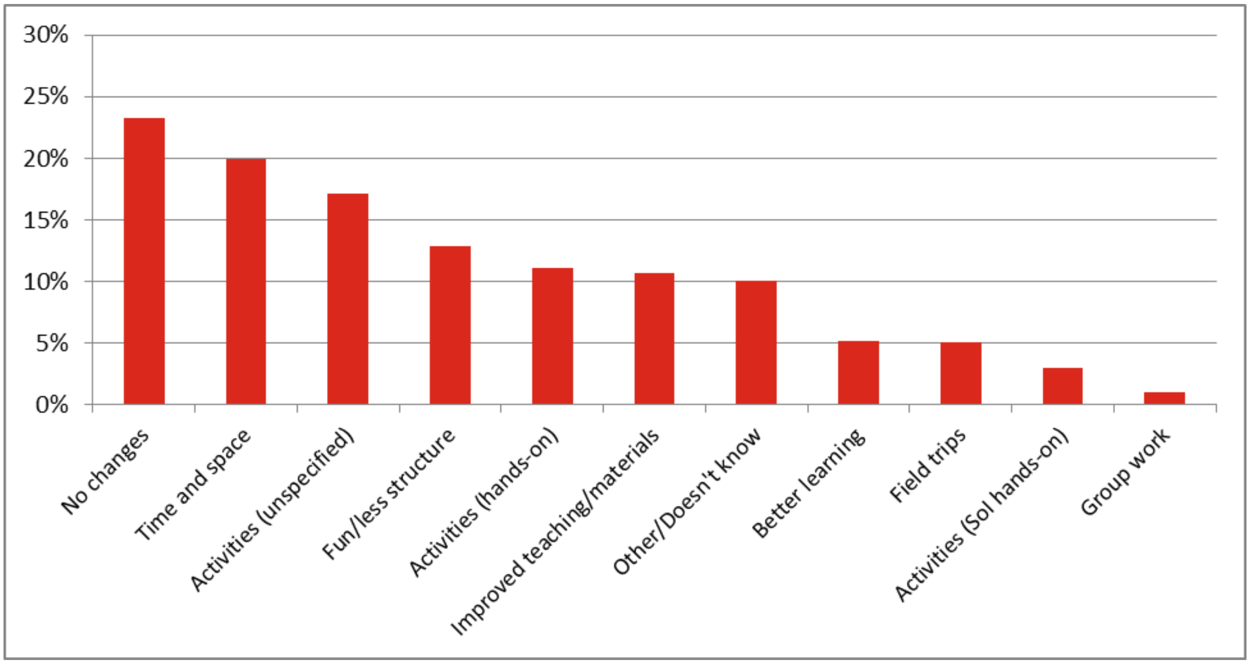
Recommended Changes to SoI

Nearly one quarter (23 percent) of students indicated that they would not change anything about their SoI camp experiences. Students' responses ranged from general comments to more specific suggestions about the content and nature of the activities, or about the structure of the camps (Exhibit 4.14).

Comments included general suggestions related to the activities (17 percent), which included statements such as "more experiments," "do more projects", or "have more games." Some comments suggested that students would have liked to learn more or different things (5 percent), for example, "I would change it by adding some stuff to learn." Other responses were more specific and suggested changes to hands-on activities (11 percent), such as that they would want "more building of things" or "less paperwork and more hands-on projects." In addition, some students (3 percent) pointed to specific SoI-related hands-on activities they would like to do more of such as Brush Bots and Kinect roller coasters, while an additional set of responses (5 percent) indicated that students would add more field trips, including "educational visits" to museums, science centers, or NASA related locations.

The remainder of the comments described structural components of the camp related to the curriculum, teachers, or the time and space. For example, responses suggested that students wanted more fun and less structure (13 percent), with comments such as "Instead of it being more like school, I would try my hardest to make it as 'camp-like' as possible." Twenty percent described structural improvements related to time and space. For example, students said they would "make the experience longer," or "use a school just for Summer of Innovation so it wouldn't be so crowded." Eleven percent of students felt that the teaching and/or materials needed to be better. One student remarked, "The quality of teachers needs to be better so they could make the kids interested," and another noted that they wanted, "enough supplies so each student can do their own assignment."

Exhibit 4.14: What Students Would Change about SoI



Notes: n = 597
Percents sum to more than 100 because responses could be coded into multiple categories.
Source: Summer of Innovation 2013 Student Follow-up Survey

Recommending SoI to Friends

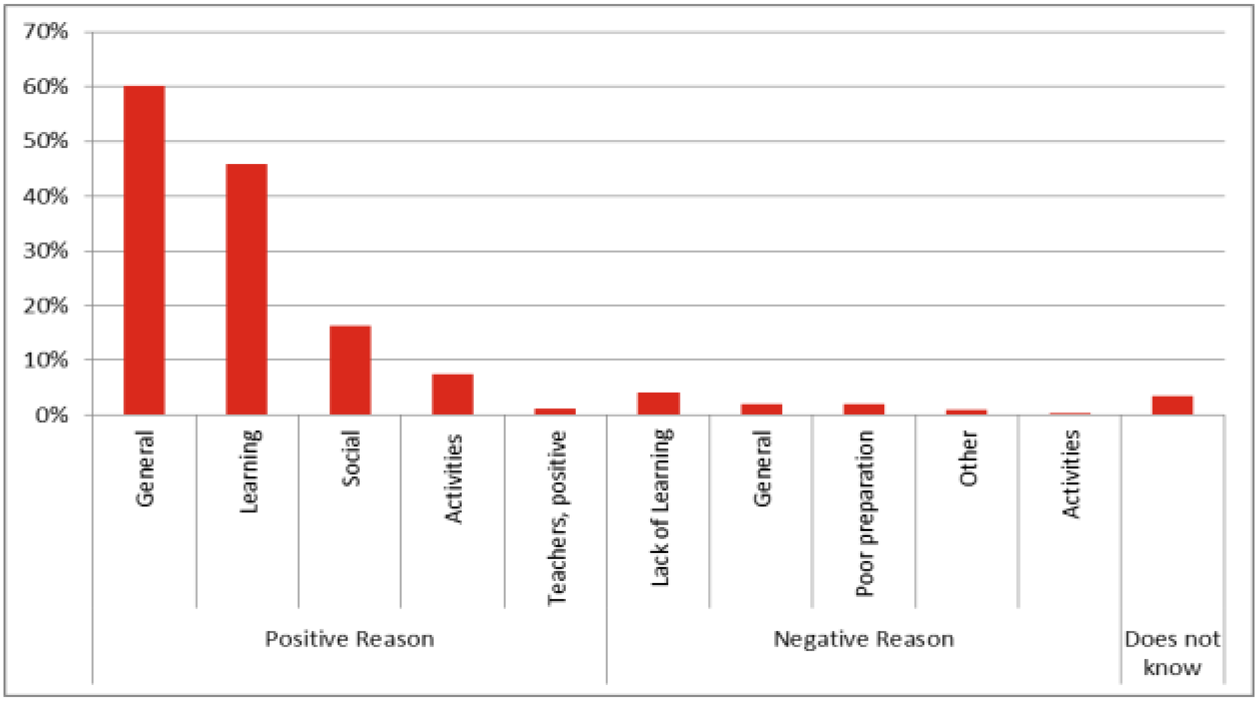
Students were asked whether they would recommend that their friends participate in SoI and then prompted to explain their answers. The overwhelming majority (91 percent) responded that they would recommend participation in SoI to their friends. Correspondingly, their comments were overwhelmingly positive. As with the other open-ended questions, students' responses ranged in the level of detail provided.

The majority of the students who responded that they would recommend SoI to friends provided a positive follow-up response, while most of those that would not recommend SoI to friends provided a negative explanation. Responses to this open-ended question were coded into five positive categories, five negative categories, and one don't know category (Exhibit 4.15).

Students described the camps as fun and engaging, and noted that they enjoyed learning. The majority of students (60 percent) indicated that they would recommend the camp to friends for general or unspecified reasons, such as "because it's fun" and "it was cool." In addition, 46 percent indicated that learning was the main reason that they would recommend the SoI camp. These responses included statements such as, "it stimulates your brain and gets you thinking," "I gained a lot of knowledge and it gave me an insight on a lot of possibilities for me in the future," and "it is a great opportunity to learn more about science outside of school." Another student stated, "you get to do a lot of experiments, have fun, and learn at the same time." Sixteen percent of the responses described the social nature of the camps. For example, one student stated "it's a fun way to meet friends and learn about space," while according to another "you can spend time with your friends and meet new people." A smaller proportion, seven percent, described the activities as reasons to recommend to friends. These responses included, "I would ask them to participate so they can enjoy creating things such as kites and rockets" and "the presentation of liquid nitrogen is really something to look forward to." Finally, one percent of students indicated that the reason they would recommend the SoI camp to their friends was related to the teachers, with comments such as “it was very fun and the teachers are nice.”

The most common negative reason that students reported was a lack of learning (cited by four percent of students), which included statements such as “because we do the same thing every year” and “Summer of Innovation was not organized and did not help me expand on my knowledge of science.” Other students’ comments suggested that camps were not well-prepared and 2 percent of students made general negative comments, including “I didn’t like it that much.”

Exhibit 4.15: Students’ Reasons for Recommending or Not Recommending SoI



Notes: n = 620
Percentages sum to more than 100 because responses could be coded into multiple categories.
Students who indicated their friends already attend SoI camp were not included in this question.
Source: Summer of Innovation 2013 Student Follow-up Survey

Overall, across all three open-ended questions students’ responses indicate that the hands-on or “fun” nature of the activities were among the most compelling aspects of the program. Even when asked what they would change or the reasons why they would not recommend SoI, many students indicated that they would add more fun or hands-on activities and more opportunities to learn. Few responses indicated that students did not enjoy their SoI experience. Among the few who provided negative responses, students most commonly indicated that the activities were not engaging or exciting, or that they did not learn anything new.[42]

4.4 Outcomes

The evaluation investigated whether there were observable changes in students on key outcomes of interest. Specifically the evaluation compared student responses before their participation in the 2013 SoI

[42] Because of the small number of camps included in the evaluation it is not possible to examine potential relationships between negative responses and camp characteristics.

camps with their responses in fall 2013. In addition to looking at changes for all students, analyses explored whether there were important differences observed by subgroups of interest.

4.4.1 Involvement in STEM Extracurricular Activities

Engagement in extracurricular STEM activities was measured by asking students whether they had engaged in a set of activities during the academic year. The baseline survey referred students to the previous academic year (2012-2013), while the follow-up survey asked students to refer to the current academic year (2013-2014). Since the follow-up survey was administered in the fall, the two time periods are not directly comparable.[43] Exhibit 4.16 presents students' involvement in STEM extracurricular activities as reported on students' first day at camp and the following fall, first for all students and then for subgroups based on characteristics of interest. Because the questions about student activities referred to different lengths of time, statistical tests were not conducted; instead the aggregate responses collected on the baseline survey about the 2012-2013 school year are presented alongside the fall responses about participation during the 2013-2104 school year.

More students reported participating in science clubs in the fall of 2013-2014 than had reported participating in science clubs during the full 2012-2013 year. Slightly more students also reported participating in a science study group or tutoring in fall 2012-2013 than in the previous year (9.4 versus 7.8 percent). However, fewer students reported participating in a science competition (16.3 versus 18.7 percent) or in science camp (7.8 versus 23.2 percent) during the fall than in the previous year.

These relative patterns were generally reflected across all student subgroups, with a few exceptions (marked in bold in the table). Females reported less participation in study groups or tutoring in the fall than during the previous year. Also, some differences by grades were seen. Specifically, more seventh graders reported participating in science competitions in the fall than in the previous year, eighth graders reported a similar amount of science competitions and study group/tutoring in the fall as in the previous year, and ninth graders reported similar involvement in science clubs in the two periods and less study group/tutoring in the fall.

[43] The follow-up survey was conducted in the fall in order capture student interest and engagement in science a few months after SoI (so as not to be inflated by last day of camp excitement) and students' experiences in school after participation in SoI.

Exhibit 4.16: Involvement in STEM Extracurricular Activities, Overall and by Student Characteristics

	% Participating in School Year									
	Science Club		Science Competition		Science camp[a]		Science study groups or tutoring		None of these	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Overall										
All students (n=577)	7.8	13.7	18.7	16.3	23.2	7.8	7.8	9.4	58.4	66.0
Gender										
Female (n=250)	4.0	12.0	16.0	14.0	25.0	7.0	**9.0**	**8.0**	58.0	67.0
Male (n=324)	10.0	15.0	21.0	18.0	22.0	8.0	6.0	11.0	58.0	65.0
Grade										
6th Grade (n=239)	6.0	14.0	21.0	15.0	30.0	8.0	8.0	11.0	53.0	67.0
7th Grade (n=172)	9.0	11.0	**17.0**	**22.0**	21.0	8.0	6.0	8.0	60.0	62.0
8th Grade (n=116)	9.0	21.0	**16.0**	**16.0**	19.0	11.0	**8.0**	**8.0**	62.0	64.0
9th Grade (n=50)	**6.0**	**6.0**	18.0	8.0	10.0	0.0	**14.0**	**10.0**	68.0	80.0
Underrepresented Racial/Ethnic Group										
Underrepresented (n=394)	7.0	11.0	18.0	16.0	22.0	8.0	8.0	10.0	59.0	66.0
Not URM (n=160)	9.0	21.0	20.0	17.0	25.0	7.0	7.0	8.0	58.0	64.0
Parental Education										
Associate's Degree or Higher (n=350)	7.0	13.0	21.0	17.0	26.0	7.0	**9.0**	**8.0**	56.0	66.0
Less than an Associate's Degree (n=198)	9.0	16.0	**16.0**	**16.0**	19.0	9.0	6.0	11.0	62.0	64.0

Notes:
Ns to do not equal the total number of follow-up surveys returned (636) because of missing survey data.
Responses do not sum to 100 because more than one response could be selected.
In the baseline survey, students were asked, "Since the beginning of the last school year (2012-2013), which of the following activities have you participated in?
In the follow-up survey, students were asked, "Which of the following activities are you participating in during this school year (2013-2014)?" As a result, the reference period students were asked about in the baseline survey was longer than that asked in the follow-up survey.
[a] In the follow-up survey, this response option was adjusted to read, "Science camp, not including Summer of Innovation."
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

4.4.2 Changes in Science Engagement

Engagement and interest in science was measured using: a series of questions from the Common Instrument that comprise the Enthusiasm for Science scale and individual items that gauged interest in design and hand-on STEM activities, interest in out-of-school STEM activities, and general interest in science. As previously noted, when looking at students' baseline engagement ratings and in comparison to their peers from the PEAR CIV dataset and those in the NAEP sample, students scored high on all measures of engagement prior to starting SoI. On average, SoI students rated their engagement slightly higher on all four measures in the fall compared with their levels of engagement when they began SoI, with significantly higher differences (bolded below) found in enthusiasm for science and interest in out-of-school STEM activities (Exhibit 4.17). However, the magnitudes of these positive changes are all relatively small. According to Cohen (1988), standardized effect sizes of .20 and smaller are considered small and the largest estimated effect size was .12 on Enthusiasm for Science scale (see Appendix J for the estimated effect sizes for all of the outcomes).

Exhibit 4.17: Estimated Change in Science Engagement Measures

	N	Estimated Baseline Mean	Estimated Follow-up Mean	Estimated Difference	Standard Error (SE)	P-Value
Enthusiasm for Science scale	1044	3.04	3.14	**0.10****	0.027	0.001
Interest in design and hands-on STEM activities	1041	3.17	3.20	0.04	0.027	0.212
Interest in out-of-school STEM activities	1037	2.57	2.64	**0.07***	0.031	0.045
General interest in science	1036	3.02	3.09	0.06	0.030	0.051

Notes: * p<.05, ** p<.01, *** p<.001
Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures, see section 3.4.2 above for more details on the imputation method.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

Analyses also explored whether the changes in engagement with science differed by key student characteristics (Exhibit 4.18). Students from racial/ethnic groups underrepresented in STEM, on average, had a larger positive change from baseline to follow-up on the enthusiasm for science scale and in their interest in out-of-school STEM activities than White/Asian students (effect sizes of .06 and .07, respectively). Also, students whose parents had an Associate's Degree or higher, had larger average positive changes on the enthusiasm for science scale, than their peers whose parents had completed less education (effect size of .11). Similar to the overall changes on science engagement measures, the magnitudes of these positive changes are all relatively small (see Appendix J for the estimated effect sizes for all of the relationships).

Exhibit 4.18: Estimated Effects of Student Characteristics on Change in Science Engagement Measures

	Enthusiasm for Science scale (n=1044)			Interest in design and hands-on STEM activities (n=1041)			Interest in out-of-school STEM activities (n=1037)			General interest in science (n=1036)		
	Estimated Change	SE	P-Value	Estimated Change	SE	P-Value	Estimated Change	SE	P-Value	Estimated Change	SE	P-Value
Female	-0.024	0.031	0.431	0.021	0.043	0.618	0.012	0.040	0.766	0.051	0.043	0.232
Grade	0.022	0.016	0.156	-0.007	0.021	0.754	0.024	0.020	0.235	0.022	0.022	0.299
Underrepresented in STEM	**0.075***	0.037	0.043	0.002	0.049	0.975	**0.108***	0.047	0.021	0.080	0.051	0.116
Parental Education - Associate's Degree or Higher	**0.113*****	0.033	0.001	-0.008	0.045	0.861	0.080	0.043	0.060	0.043	0.046	0.346

Notes: * p<.05, ** p<.01, *** p<.001
Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures, see section 3.4.2 above for more details on the imputation method.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

4.5 Benchmarking

Benchmark comparisons were conducted using PEAR's CIV dataset that includes a sample of middle school students involved in out-of-school science programming as well as using national data from the National Assessment of Educational Progress. Records in the PEAR CIV benchmark dataset are not linked between pre- and post-participation and the NAEP is a single point in time administration, and thus change in these measures could not be estimated. Instead, straight comparisons are made at each of the time points, baseline and follow-up for the PEAR CIV sample and baseline for the NAEP sample.

Exhibit 4.19 displays SoI students' mean level of interest in science, as measured by the Enthusiasm for Science scale, relative to PEAR's CIV benchmark sample of middle school students involved in out-of-school science programming. Means at both time points for both sets of students are greater than the scale mid-point (of 2.5), suggesting that students in both samples are interested in science. At both baseline and follow-up, the SoI student mean on the Enthusiasm for Science scale is slightly higher than that of the PEAR CIV benchmark sample and the differences are statistically significant at each time point.

Exhibit 4.19: Enthusiasm for Science Scale Benchmark Comparison

	Baseline				Follow-up			
	SoI[a] (n=1044)		PEAR[b] (n=1173)		SoI[a] (n=593)		PEAR[b] (n=576)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Enthusiasm for Science scale[c]	3.0	0.5	2.9	0.6	3.2	0.5	2.8	0.7

[a] Source: Summer of Innovation 2013 Student Baseline and Follow-Up Surveys
[b] Source: Program in Education, Afterschool & Resiliency (PEAR) Common Instrument Validation (CIV) national benchmarking baseline and follow-up data.

Further, SoI students scored higher than the NAEP national sample and the PEAR CIV benchmark sample of middle school students on selected science-related NAEP items. Exhibit 4.20 shows that on average SoI students more frequently reported doing more science related activities, that science was a favorite subject, and aspiring to have a science or computer job than did students from the PEAR or NAEP samples. The SoI students rated four of the NAEP items more favorably than the PEAR CIV benchmark sample, and three of these differences were statistically significant ("I do science-related activities that are not for schoolwork," "Science is one of my favorite subjects," and "I take science only because I have to").[44]

[44] Tests of statistical significance were not possible between the SoI sample and the NAEP sample because only the public-use aggregate NAEP data were available for this evaluation.

Exhibit 4.20: Benchmark Comparison of Selected NAEP Items

	Baseline				Follow-Up				NAEP
	SoI[a]		PEAR[b]		SoI[c]		PEAR[d]		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean
Selected NAEP Items									
I do science-related activities that are not for schoolwork	2.6	0.9	2.6	1.0	2.6	0.9	2.5	1.0	2.1
Science is one of my favorite subjects	3.0	1.0	2.8	1.1	3.2	0.9	2.6	1.0	2.4
I take science only because I have to	1.9	1.0	2.1	1.0	1.8	0.9	2.2	1.0	2.4
I take science only because it will help me in the future	2.5	1.0	2.5	1.0	2.3	1.0	2.5	1.0	2.7
I would like to have a science or computer job in the future[d]	2.6	1.0	-	-	2.9	0.9	-	-	2.2

[a] Source: Summer of Innovation 2013 Student Baseline Survey
Ns range from 1010 to 1034.
[b] Source: Program in Education, Afterschool & Resiliency (PEAR) national benchmarking baseline data.
Ns range from 929 to 1155.
[c] Source: Summer of Innovation 2013 Student Follow-up Survey
Ns range from 580 to 588.
[d] Source: Program in Education, Afterschool & Resiliency (PEAR) national benchmarking follow-up data.
Ns range from 435 to 564.
[c] Source: 2009 8th grade National Assessment of Educational Progress (NAEP) national data.
Ns and standard deviations for these items were not available.
[f] In NAEP's original survey, this item is worded, "When I graduate from high school, I would like to have a job related to science." NAEP data are based on responses to this question, not to NASA's phrasing (above). Data for this question were not available from PEAR. Also, while NAEP's national benchmark data for all of the other NAEP items included in the table came from a national survey of 8th graders in 2011, NAEP's data for this item was based on questions only asked of 12th graders in 2009.

4.6 Change in Student Engagement and Camp Characteristics

Additional analyses explored whether variation in camp characteristics might be associated with variation in change in student outcomes, namely the percent of students attending at least half of the camp sessions, the percent of certified teachers, educator-student ratio, and ratings on the DoS (Exhibit 4.21).[45] The findings suggest that it is not enough to keep students in camp, but rather, the structure and quality of their experiences in the camps matter.

Specifically, while a larger percentage of students attending the majority of camp was associated was less positive change in student interest in out-of-school STEM activities (hence the negative sign on the estimated effect reported) having more educators per students (i.e. a higher educator to student ratio) was associated with greater positive changes on the Enthusiasm for Science scale and in general interest in science. Further, the overall quality of the classroom experience, as measured across dimensions by DoS,

45 There was not enough variation in the reported hours of SoI content to include that camp characteristic in the analysis.

was positively associated with changes in three of the four engagement measures: enthusiasm for science, interest in design and hands-on STEM activities.[46]

Exhibit 4.21: Estimated Effects of Camp Characteristics and Quality on Change in Science Engagement Measures

	Enthusiasm for Science scale			Interest in design and hands-on STEM activities			Interest in out-of-school STEM activities			General interest in science		
	Estimated Effect	SE	P-Value	Estimated Effect	SE	P-Value	Estimated Effect	SE	P-Value	Estimated Effect	SE	P-Value
Camp Characteristics	**(n = 1044)**			**(n = 1041)**			**(n = 1037)**			**(n = 1036)**		
Percentage of students attending at least half of camp session	-0.001	0.003	0.6667	0.002	0.003	0.5040	**-0.007***	0.003	0.0113	0.004	0.003	0.2267
Percentage of certified K-12 teachers	0.001	0.001	0.4932	0.001	0.001	0.0612	**0.002****	0.001	0.0053	0.000	0.001	0.6963
Educator-student ratio[a]	**0.006***	0.003	0.0148	0.004	0.003	0.2378	0.006	0.004	0.1202	**0.011*****	0.003	0.0002
Dimensions of Success	**(n=834[b])**			**(n = 831[b])**			**(n = 829[b])**			**(n = 826[b])**		
Percent of 3 or 4 ratings on dimensions[c]	**0.003*****	0.001	0.0002	**0.002***	0.001	0.0178	**0.003****	0.001	0.0011	0.000	0.002	0.8610

Notes: * p<.05, ** p<.01, *** p<.001
Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures, see section 3.4.2 above for more details on the imputation method.
[a]Educator-Student ratio as reported by camps. Higher numbers indicate that there were more educators per student.
[b]Classroom observations were only conducted in eight of the 11 sites represented in the student surveys, reducing the sample size for these analyses.
[c]Two classrooms per camp were observed on two different days. Therefore, all camps had four observations. To aggregate across observations, we calculated the percentage of the four observations that were rated a 3 or 4 across all dimensions.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys. Summer of Innovation 2013 Performance Data; Summer of Innovation 2013 Dimensions of Success Data.

The relationships reported in Exhibit 4.21 suggest that changes in student engagement are greater at higher quality camps and those with more certified K-12 teachers, higher educator-student ratios, and smaller proportions of students attending more of the sessions. However, these associations between change in student science engagement and camp characteristics and quality are small (none of the estimated effect sizes are greater than .13, see Exhibit J.3 in Appendix J) and are based on a relatively small sample of camps. Further, the analysis does not control for other camp attributes that may account for the apparent relationships such as camp material resources or camp content. Therefore, the results should be interpreted as suggestive associations and not causal.

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46 Not only is the overall DoS rating associated with change in student science engagement, but so too are many of the individual dimensions of classroom quality. Seven of the DoS dimensions were positively associated with increases on the Enthusiasm for Science scale, four dimensions were positively associated with increases in interest in design and hands-on STEM activities, six dimensions were positively associated with increases in interest in out-of-school STEM activities, and one dimension was positively associated with increases in general science interest (see Appendix K for the estimated effects). Only the two dimensions (relationships and reflection) were not statistically significantly associated with changes in science engagement.

5. Conclusion

5.1 Discussion

Below, we summarize the key findings and discuss how they relate to each of the outcomes research questions.

5.1.1 Are SoI students' levels of STEM interest and engagement similar at the start of SoI and in the fall?

Do students report participating in STEM—in-school, extracurricular, or out-of-school—more frequently since SoI participation than they did in the previous school year? Are there differences by subgroups?

A comparison of students' reported participation in extracurricular science activities during the 2012-2013 school year to participation in similar activities in the fall of the 2013-2014 school year showed that there were some activities (science club and science study groups or tutoring) in which more students reported participating in the fall of 2013 after participation in SoI, while there were other activities (science competition and science camp) in which a smaller percent of SoI students reported participating in the fall of 2013. However, it is not possible to attribute change to participation in SoI because: the reference periods differ in length (i.e., the entire 2012-2013 school year and only the fall of the 2013-2014 school year), one time period is at the beginning of a school year when students may be more enthusiastic about clubs and other activities, and access to activities could be contingent upon grade level which also differs between reference periods.

There were no systematic patterns of differences by subgroups explored, inclusive of gender, grade, racial/ethnic group, grade, and parental education. Across all subgroups the percent of students reporting participation in a science club either remained the same or increased slightly from the 2012-13 school year to the fall of 2013, and the percent of students reporting science camp participation decreased between the two periods.

Did self-reported interest in STEM change significantly between the baseline and follow-up surveys? Are there differences by subgroups?

Baseline survey data demonstrated that students expressed high existing interest in key SoI outcomes prior to the start of the summer activities. Nonetheless, in the fall, students reported even higher levels of enthusiasm for science, interest in design/hands-on activities, interest in out-of-school STEM activities, and general interest in science. While two of the differences (enthusiasm for science and interest in out-of-school STEM activities) were statistically significant, in practical terms the changes were small; one-tenth or less of one point on the four-point scale. These results suggest minimal increases in self-reported enthusiasm for science and interest in out-of-school STEM activities between the baseline survey and the fall follow-up survey.

Exploration of potential subgroup differences found that students from racial/ethnic groups underrepresented in STEM, on average, had slightly larger positive changes from baseline to follow-up in their enthusiasm for science and interest in out-of-school STEM activities than did students not from underrepresented racial/ethnic groups (i.e. Whites and Asians). Also, students whose parents had an Associate's Degree or higher had larger average positive changes compared to peers whose parents had completed less education.

To what degree does SoI youth self-reported interest in STEM at follow-up differ from youth involved in other out-of-school time programming?

Examining SoI students' self-reported engagement and interest in STEM in comparison to middle school students participating in other out-of-school STEM programs provides context for the SoI student results. Students who participated in SoI expressed higher existing interest in science, as measured by the Enthusiasm for Science scale prior to the start of the summer activities than peers starting other out-of-school STEM programs. Similarly, SoI students expressed greater interest in science in the fall, compared with the interest expressed by peers at the completion of other out-of-school STEM programs. Further, SoI students scored higher on selected science-related NAEP items than both the NAEP national sample and their comparison peers in other STEM out-of-school programs. SoI students appear to enter the summer camp with higher interest in science than their peers and their interest remains above that of their peers into the fall, after completing summer camp.

5.1.2 Are there correlations between camp characteristics and program quality and the student attitudes and behaviors?

Exploratory analyses suggested the existence of associations between key camp characteristics and student outcomes. Namely, the higher the percent of certified teachers the greater the increase in interest in out-of-school STEM activities. Also, a higher educator-to-student ratio was associated with more positive change on the Enthusiasm for Science scale and in general interest in science. The qualifications and number of educators appear to be associated with positive change in student interest in and enthusiasm for science. The magnitude of these associations was relatively small, with the largest association (between the educator-student ratio and general science interest) suggesting that adding an additional educator would, on average, increase students' general science interest by only one-tenth of one point on the four-point scale.

A small, inverse relationship was found between the percent of students who attended at least half of the camp and interest in out-of-school STEM activities such that as a larger percent of a camp's students attend the majority of the camp session the smaller the estimated change in student interest. This finding suggests that the quality of programming offered during camp sessions is more important in increasing student interest in STEM than getting students to attend the majority of a camp session.

Classroom quality also appeared to be related to student outcomes. The higher the DoS classroom quality ratings the larger the estimated increase in student scores on the Enthusiasm for Science scale, in interest in design and hands-on STEM activities and in interest in out-of-school STEM activities. Camps with higher quality classrooms seem to be associated with larger increases in student science engagement.

5.2 Recommendations

This report presented key outcomes for students at camps that implemented the SoI stand-alone model in FY2013. Based on these findings, the following recommendations are made for consideration as the SoI project and other NASA out-of-school time STEM programming continue to move forward.

- Teachers and students reported that the hands-on nature of the activities were the most compelling aspects of the camps. Further, prior research suggests that activities that provide students with authentic experiences that encourage active questioning and problem solving can increase students' enthusiasm and engagement in science. Therefore, NASA should continue to emphasize the importance of incorporating hands-on and problem solving activities in SoI, increasing the proportion of camp time for these activities and providing additional professional development opportunities to help teachers successfully implement hands-on activities.

- Recent research suggests that interest in STEM may be related to student preferences for particular types of learning activities, in particular discovery, creating, making activities—the types of activities often emphasized in SoI (Tai, 2014). Further attention to the types of activities engaged in during SoI could provide insight into why particular students are attracted to SoI and how programming could be structured to foster the greatest long-term interest in STEM.
- Characteristics of staff and the number of camp staff appear to be related to more positive changes in student interest and engagement in science. NASA should encourage camps to employ K-12 certified teachers and maintain educator-to-student ratios of 1:20 or higher as these staffing strategies appear related to positive changes in student interest and engagement in science.
- Students could have many experiences, both in and out of school, that affect their interest and engagement in STEM in between participation in SoI during the summer and the late fall of the subsequent school year. These additional experiences make it difficult to attribute any observed changes to SoI participation. If establishing a more direct link between SoI participation and change in interest and engagement is a project goal, future evaluation efforts could include a contemporaneous comparison group and should measure student outcomes at the start of the camp and close to the conclusion of camp.
- Measuring outcomes at different time points during the year may introduce other factors, such as increased enthusiasm for clubs and new activities at the beginning of the school year, that make it difficult to attribute positive change to participation in SoI. Implementing an evaluation design that includes a contemporaneous comparison group could allow for a more rigorous examination of changes in extracurricular activity participation.
- The correlational analysis of camp characteristics and student outcomes was limited to characteristics that varied across study sites and to those for which there were available data. Future evaluation could include a larger sample of SoI camps to better understand variation in student outcomes attributable to camp quality and characteristics.
- Continued use of the DoS will likely provide additional valuable information about successful implementation of SoI and how camp quality relates to student outcomes. Training of camp educators should focus on improving the quality of the experiences that camps provide, particularly by increasing educators' understandings of how to incorporate elements such as student reflection, relevance of activities for students' lives, and student understanding of STEM concepts, or how to structure camp programs and activities to increase the number of instructors present.
- The SoI project has successfully engaged a large proportion of students from groups that are traditionally under-represented in STEM. However, SoI students' high levels of motivation have implications for future considerations around recruitment and outreach. NASA will need to determine whether it is important to reach students who may not otherwise have been interested in STEM content. Future evaluations could examine recruitment procedures.

Appendix A. Parent Survey

Summer of Innovation Parent Survey

We are delighted that your child will be part of NASA's Summer of Innovation. Parents of youth attending this program are being asked to complete this survey. NASA wants to learn more about the youths and their parents taking part in NASA experiences so that we can improve what we offer in the future. There are no "right" or "wrong" answers to any of the questions. The survey should take about 8 minutes to complete the questions.

Your participation in the evaluation is voluntary. Your child can take part in the program even if you do not take part in the survey.

Securing Your Responses

Protecting your and your child's privacy is very important to us.

- NASA's Office of Education, the research organizations doing the evaluation, and the program's staff will follow strict rules to protect the information you provide.
- The evaluation reports will not include your name, your child's name, or the name of your child's school.
- We will not share information that identifies you or your child to anyone outside the evaluation team and the Summer of Innovation staff, except as required by law.

Questions about the Evaluation

- For questions about the evaluation, please email Dr. Patricia Moore Shaffer, NASA's Office of Education Evaluation Manager, at patricia.a.shaffer@nasa.gov or call 202-358-5230 (toll call).
- For questions about your child's rights as a participant in this evaluation, please call Abt's Institutional Review Board Administrator, Teresa Doksum at 877-520-6835 (toll-free).

If you wish to participate in this study, please turn the page.

Paperwork Reduction Act Statement - This information collection meets the requirements of 44 U.S.C. § 3507, as amended by section 2 of the Paperwork Reduction Act of 1995. You do not need to answer these questions unless we display a valid Office of Management and Budget control number. The OMB control number for this collection is <insert number and expiration date>. We estimate that it will take 8 minutes to read the instructions, gather the facts, and answer the questions. Send comments relating to our time estimate above to the NASA Office of Education at HQ-OEIDAdmin1@mail.nasa.gov.

NASA Privacy Policy - This notice provides NASA's policy regarding the nature, purpose, use and sharing of any information collected via this form. The information you provide on a NASA-issued form will be used only for its intended purpose. NASA will protect your information consistent with the principles of the Privacy Act, the e-Government act of 2002, the Federal Records Act, and as applicable, the Freedom of Information Act. Submitting information is strictly voluntary. By doing so, you are giving NASA your permission to use the information for the intended purpose. If you do not want to give NASA permission to use your information, simply do not provide it. However, not providing certain information may result in NASA's inability to provide you with the information or services you desire. For additional information please visit NASA Privacy Policy and Important Notices at http://www.nasa.gov/about/highlights/HP_Privacy.html.

1. Child's first name: ________________ Last name: __________________________

2. What is your child's birthday (MM/DD/YYYY)?:_ Month: __ Day:__ Year: ____

3. What grade level will your child enter in fall 2013?
   ❑4th ❑5th ❑6th ❑7th ❑8th ❑9th ❑Other: ________________________

4. What is your child's gender? ❑Male ❑Female

5. Is your child Hispanic or Latino/Latina? ❑ Yes ❑ No

6. What is your child's race? Check one or more.
   ❑American Indian or Alaska Native
   ❑Asian
   ❑Black or African American
   ❑Native Hawaiian or Other Pacific Islander
   ❑White

7. What is the highest level of education you have completed?
   ❑ Less than high school ***(Skip to Question 10)***
   ❑ High school diploma or GED ***(Skip to Question 10)***
   ❑ Associate's degree
   ❑ Bachelor's degree
   ❑ Master's degree
   ❑ Ph.D., M.D., law degree, or other high level professional degree

8. Do you have a degree in a science, technology, engineering, or mathematics field?
   ❑Yes ❑No ❑I don't know

9. Do you work in a science, technology, engineering, or mathematics-related occupation?
   ❑Yes ❑No ❑I don't know

10. During the last 12 months, has your child participated in any of the following activities outside of school? Check all that apply.
    ❑ Music, dance, art, or theater
    ❑ Organized sports supervised by an adult
    ❑ Religious youth group or religious instruction
    ❑ Scouting or another group or club activity
    ❑ Academic instruction outside of school such as from a Saturday Academy, learning center, personal tutor or summer school program
    ❑ A math or science camp
    ❑ Another camp
    ❑ None of these

11. Why is your child attending Summer of Innovation? Check all that apply.
    - ❑ To have fun
    - ❑ To learn more about NASA and space
    - ❑ To have something to do
    - ❑ To learn more about science
    - ❑ To learn about what scientists and engineers do
    - ❑ To meet others with interests similar to my child
    - ❑ Help my child to do well in school
    - ❑ Not sure

12. How did you hear about Summer of Innovation? Check all that apply.
    - ❑ A teacher
    - ❑ A friend or family member
    - ❑ Newspaper or other advertisement
    - ❑ Web/Internet search
    - ❑ Received something in the mail
    - ❑ School or community center
    - ❑ Other

13. We also ask that you provide contact information.

Your Contact Information

Your first name: ____________________ Your last name: ________________________

Telephone no.: ( )___________________ Alternative telephone no.: ( ) ______________________

Best time to call:____

Permanent email address (optional):____

Alternative email address (optional): ____

Student mailing street address:____

City:_____________________ State: _________ Zip code: ______________

Emergency Contact (other than parent) Information

Please provide contact information for a responsible adult should you not be available.

First Name:__________________________ Last Name: ____________________________

Relationship to student: ____

Telephone no.: ( ) ____________________ Alternative telephone no.: ( ) ____________________

Best time to call: ____

Thank you!

Appendix B. Student Baseline Survey

Summer of Innovation Youth Survey (Baseline)

Congratulations on taking part in NASA’s Summer of Innovation! To improve this program for the future, all students who attend this program are being asked to complete a survey. There are no “right” or “wrong” answers to any of the questions. We want your honest opinions. It should take about 6 minutes to complete the questions. Thank you very much for your help!

NASA and its research team follow strict rules to make sure that only they will see your answers to this and future surveys for this program, except as required by law. No report will use your name or describe you in any way that could identify you.

If you wish to participate in this study, please continue.

Paperwork Reduction Act Statement: This information collection meets the requirements of 44 U.S.C. § 3507, as amended by section 2 of the Paperwork Reduction Act of 1995. You do not need to answer these questions unless we display a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is <insert number/expiration date>. We estimate that it will take 6 minutes to read the instructions, gather the facts, and answer the questions. ***Send only comments relating to our time estimate above to*:** **HQ-OEIDAdmin1@mail.nasa.gov**.

NASA Privacy Policy - This notice provides NASA's policy regarding the nature, purpose, use and sharing of any information collected via this form. The information you provide on a NASA-issued form will be used only for its intended purpose. NASA will protect your information consistent with the principles of the Privacy Act, the e-Government act of 2002, the Federal Records Act, and as applicable, the Freedom of Information Act. Submitting information is strictly voluntary. By doing so, you are giving NASA your permission to use the information for the intended purpose. If you do not want to give NASA permission to use your information, simply do not provide it. However, not providing certain information may result in NASA's inability to provide you with the information or services you desire. For additional information please visit NASA Privacy Policy and Important Notices at http://www.nasa.gov/about/highlights/HP_Privacy.html.

Tell NASA about yourself

1. Your first name: ____________________ Your last name: _____________________________

2. What is your birthday (MM/DD/YYYY)?: Month: ___ Day:___ Year: ______

3. What grade level will you enter in fall 2013?
   ❑4th ❑5th ❑6th ❑7th ❑8th ❑9th ❑Other: ____________________

4. As things stand now, how far in school do you think you will get?
   - ❑ Less than high school
   - ❑ Earn a high school diploma or GED
   - ❑ Complete an Associate's degree
   - ❑ Complete a Bachelor's degree
   - ❑ Complete a Master's degree
   - ❑ Complete a Ph.D., M.D., law degree, or other high level professional degree
   - ❑ I don't know

5. Why did you sign up for Summer of Innovation? Check all that apply.
   - ❑ To have fun
   - ❑ To learn more about NASA and space
   - ❑ To have something to do
   - ❑ To learn more about different majors in college (e.g., engineering, science)
   - ❑ To learn more about science
   - ❑ To learn about what scientists and engineers do
   - ❑ To make my parents/guardians happy
   - ❑ To meet others with interests similar to mine
   - ❑ To help me to do well in school
   - ❑ None of these

6. Have you ever been in another Summer of Innovation camp?
   - ❑ Yes
   - ❑ No
   - ❑ I don't know

Tell NASA about your science activities in and outside of school

7. What science class did you take last year?
   - ❑ Science or General Science
   - ❑ Life Science
   - ❑ Earth Science
   - ❑ Physical Science
   - ❑ Integrated or Coordinated Science
   - ❑ Other science course
   - ❑ I don't know

8. How much do you agree or disagree with the following statements about your 2012-13 science class?

	Never	Rarely	Sometimes	Often
a. I enjoyed this class very much	1	2	3	4
b. I thought this class was a waste of my time	1	2	3	4
c. I thought this class was boring	1	2	3	4

9. Since the beginning of the last school year (2012-2013), which of the following activities have you participated in? Check all that apply.
   - ❑ Science club
   - ❑ Science competition
   - ❑ Science camp
   - ❑ Science study groups or a program where you were tutored in science
   - ❑ None of these

10. Since the beginning of the last school year (2012-2013), how often have you done the following science activities?

Activity	Never	Rarely	Sometimes	Often
a. Read science books and magazines	1	2	3	4
b. Access web sites for computer technology information	1	2	3	4
c. Visit a science museum, planetarium, or environmental center	1	2	3	4
d. Play games or use kits or materials to do experiments or build things at home	1	2	3	4
10.5 Watch programs on TV about nature and discoveries	1	2	3	4

Tell NASA your opinions about science

The next series of questions contain a number of statements about science. You will be asked what you think about these statements. There are no "right" or "wrong" answers. We just want your opinions. For this survey, the word "science" covers a broad range of topics, including space and planets, animals and plants, medicine, computer programming, and designing things like machines.

11. Please indicate the extent to which you agree or disagree with each of the following statements. Select ONE in each row.

		Strongly Disagree	Disagree	Agree	Strongly Agree
11.1	Science is something I get excited about	1	2	3	4
11.2	I like to take things apart to learn more about them	1	2	3	4
11.3	I like to participate in science projects	1	2	3	4
11.4	I'd like to get a science kit as a gift (for example, a microscope, magnifying glass, a robot, etc.)	1	2	3	4
11.5	I like to see how things are made (for example, ice-cream, a TV, an iPhone, energy, etc)	1	2	3	4
11.6	I like to watch programs on TV about nature and discoveries	1	2	3	4
11.7	I am curious to learn more about science, computers or technology	1	2	3	4
11.8	I like to work on science activities	1	2	3	4
11.9	If I have kids when I grow up, I will take them to a science museum	1	2	3	4
11.10	I would like to have a science or computer job in the future.	1	2	3	4
11.11	I want to understand science (for example, to know how computers work, how rain forms, or how airplanes fly)	1	2	3	4
11.12	I enjoy visiting science museums or zoos	1	2	3	4
11.13	I get excited about learning about new discoveries or inventions	1	2	3	4
11.14	I like reading science magazines	1	2	3	4
11.15	I pay attention when people talk about recycling to protect our environment	1	2	3	4
11.16	I am curious to learn more about cars that run on electricity	1	2	3	4
11.17	I get excited to find out that I will be doing a science activity	1	2	3	4
11.18	I enjoy reading science fiction books	1	2	3	4

	Strongly Disagree	Disagree	Agree	Strongly Agree
11.19 I like learning about science on the internet	1	2	3	4
11.20 I like online games or computer programs that teach me about science	1	2	3	4
11.21 Science is boring	1	2	3	4
11.22 I do science-related activities that are not for schoolwork.	1	2	3	4
11.23 I like science	1	2	3	4
11.24 Science is one of my favorite subjects	1	2	3	4
11.25 I take science only because I have to	1	2	3	4
11.26 I take science only because it will help me in the future	1	2	3	4
11.27 Before joining this program, I was interested in science and science-related things	1	2	3	4
11.28 Before joining this program, I participated in science activities outside of school	1	2	3	4
11.29 I like to design a solution to a problem.	1	2	3	4
11.30 I like to be part of a team that designs and builds a hands-on project.	1	2	3	4
11.31 I'm curious to learn how to program a computer game.	1	2	3	4
11.32 I like to design and build something mechanical that works.	1	2	3	4

Thanks for taking the time to complete this survey!

Appendix C. Student Follow-Up Survey

Summer of Innovation Youth Follow-Up Survey

Last summer you participated in NASA's Summer of Innovation! To improve this program for the future, all students who attended this program are being asked to complete a survey. There are no "right" or "wrong" answers to any of the questions. We want your honest opinions.

Your parent said it is ok for you to take this survey. However, your participation is voluntary—you may choose not to answer a question or to stop answering the questions at any point. It should take about 6 minutes to complete the questions. Thank you very much for your help!

NASA and its research team follow strict rules to make sure that only they will see your answers to this and future surveys for this program, except as required by law. No report will use your name or describe you in any way that could identify you.

If you wish to participate in this survey, please continue.

Return your completed survey in the self-addressed stamped envelope.

Paperwork Reduction Act Statement - This information collection meets the requirements of 44 U.S.C. § 3507, as amended by section 2 of the Paperwork Reduction Act of 1995. You do not need to answer these questions unless we display a valid Office of Management and Budget control number. The OMB control number for this collection is 2700-0150, expiration 2/28/2015. Return your completed survey in the self-addressed stamped envelope. We estimate that it will take about 6 minutes to read the instructions, gather the facts, and answer the questions. *You may send comments on our time estimate above to*: by email to HQ-OEIDAdmin1@mail.nasa.gov or by mail to NASA Office of Education, 4U18, 300 E Street SW, Washington, DC, 20546-0001.

NASA Privacy Policy - This notice provides NASA's policy regarding the nature, purpose, use and sharing of any information collected via this form. The information you provide on a NASA-issued form will be used only for its intended purpose, which is to improve NASA's Summer of Innovation program based on participant feedback. Your responses will be made anonymous and aggregated for review by the Summer of Innovation program management. NASA will protect your information consistent with the principles of the Privacy Act, the e-Government act of 2002, the Federal Records Act, and as applicable, the Freedom of Information Act. Submitting information is strictly voluntary. By doing so, you are giving NASA (and its designated representatives**)** your permission to use the information for the intended purpose. If you do not want to give NASA permission to use your information, simply do not provide it. However, not providing certain information may result in NASA's inability to provide you with the information or services you desire. For additional information please visit NASA Privacy Policy and Important Notices at http://www.nasa.gov/about/highlights/HP_Privacy.html.

Today's Date: Month ___ Day ___ Year ______

Tell NASA about yourself

1. Your first name: ______________________Your last name: ______________________________

2. What is your birthday (MM/DD/YEAR)?: Month: ___ Day:___ Year: ______

3. What grade level did you begin in fall 2013?
   ❑ 4th ❑ 5th ❑ 6th ❑ 7th ❑ 8th ❑ 9th ❑ Other: _____

Tell NASA about your Summer of Innovation experience

For questions 4 through 6, please respond in whole sentences.

4. What did you like best about Summer of Innovation?

5. If you were in charge, how would you change your Summer of Innovation experience?

6. Would you recommend that your friends participate in Summer of Innovation?
   ❑ Yes ❑ No
   Please explain why or why not:

7. How much did participating in Summer of Innovation impact you?

	Not at All	Slightly	Moderately	A Great Deal
a. Increased my knowledge of NASA and space	1	2	3	4
b. Increased my interest in studying science or engineering in college	1	2	3	4
c. Helped me understand science better	1	2	3	4
d. Led me to a better understanding of my own career goals	1	2	3	4
e. Made me decide to take different classes in school (including college) than I had planned	1	2	3	4
f. Made me more confident in my ability to succeed in science	1	2	3	4
g. Increased my confidence in my ability to participate in science projects or activities	1	2	3	4
h. Helped me connect with others who have similar interests	1	2	3	4

Tell NASA about your science activities in and outside of school

8. What science class are you currently taking? If you are taking more than one science class, please choose your most advanced or difficult course.
   - ❑ Science or General Science
   - ❑ Life Science
   - ❑ Earth Science
   - ❑ Physical Science
   - ❑ Integrated or Coordinated Science
   - ❑ Other science course
   - ❑ I don't know
   - ❑ None *Skip to Question 10.*

9. How much do you agree or disagree with the following statements about your current science class?

	Never	Rarely	Sometimes	Often
a. I enjoy this class very much	1	2	3	4
b. I think this class is a waste of my time	1	2	3	4
c. I think this class is boring	1	2	3	4

10. Which of the following activities are you participating in during this school year (2013-2014)? Check all that apply.
    - ❑ Science club
    - ❑ Science competition
    - ❑ Science camp, not including Summer of Innovation
    - ❑ Science study groups or a program where you were tutored in science
    - ❑ None of these

11. Since you participated in the Summer of Innovation, how often have you done the following science activities?

Activity	Never	Rarely	Sometimes	Often
a. Read science books and magazines	1	2	3	4
b. Access web sites for computer technology information	1	2	3	4
c. Visit a science museum, planetarium, or environmental center	1	2	3	4
d. Play games or use kits or materials to do experiments or build things at home	1	2	3	4
e. Watch programs on TV about nature and discoveries	1	2	3	4

Tell NASA your opinions about science

The next series of questions contain a number of statements about science. You will be asked what you think about these statements. There are no "right" or "wrong" answers. We just want your opinions. For this survey, the word "science" covers a broad range of topics, including space and planets, animals and plants, medicine, computer programming, and designing things like machines.

12. Please indicate the extent to which you agree or disagree with each of the following statements. Select ONE in each row.

	Strongly Disagree	Disagree	Agree	Strongly Agree
a. Science is something I get excited about	1	2	3	4
b. I like to take things apart to learn more about them	1	2	3	4
c. I like to participate in science projects	1	2	3	4
d. I'd like to get a science kit as a gift (for example, a microscope, magnifying glass, a robot, etc.)	1	2	3	4
e. I like to see how things are made (for example, ice-cream, a TV, an iPhone, energy, etc.)	1	2	3	4
f. I like to watch programs on TV about nature and discoveries	1	2	3	4
g. I am curious to learn more about science, computers or technology	1	2	3	4
h. I like to work on science activities	1	2	3	4
i. If I have kids when I grow up, I will take them to a science museum	1	2	3	4
j. I would like to have a science or computer job in the future	1	2	3	4
k. I want to understand science (for example, to know how computers work, how rain forms, or how airplanes fly)	1	2	3	4
l. I enjoy visiting science museums or zoos	1	2	3	4
m. I get excited about learning about new discoveries or inventions	1	2	3	4
n. I like reading science magazines	1	2	3	4
o. I pay attention when people talk about recycling to protect our environment	1	2	3	4
p. I am curious to learn more about cars that run on electricity	1	2	3	4
q. I get excited to find out that I will be doing a science activity	1	2	3	4
r. I enjoy reading science fiction books	1	2	3	4
s. I like learning about science on the internet	1	2	3	4
t. I like online games or computer programs that teach me about science	1	2	3	4
u. Science is boring	1	2	3	4

	Strongly Disagree	Disagree	Agree	Strongly Agree
v. I do science-related activities that are not for schoolwork	1	2	3	4
w. I like science	1	2	3	4
x. Science is one of my favorite subjects	1	2	3	4
y. I take science only because I have to	1	2	3	4
z. I take science only because it will help me in the future	1	2	3	4
aa. Before joining this program, I was interested in science and science-related things	1	2	3	4
bb. Before joining this program, I participated in science activities outside of school	1	2	3	4
cc. I like to design a solution to a problem.	1	2	3	4
dd. I like to be part of a team that designs and builds a hands-on project.	1	2	3	4
ee. I'm curious to learn how to program a computer game.	1	2	3	4
ff. I like to design and build something mechanical that works.	1	2	3	4

Thanks for taking the time to complete this survey!

Return your completed survey in the self-addressed stamped envelope.

Appendix D: Survey Administration and Tracking Procedures

Parent Consent

As part of the registration materials, camps included a parent consent form that described the evaluation components (a parent survey, a student baseline survey, and a student follow-up survey) and asked parents to give consent for their own and their children's inclusion in the evaluation. Study inclusion meant that registration contact information was available to the study team, and that parents and students would be contacted in the fall about the student follow-up survey. The signed parent consent form was a required component of the SoI registration process, nonetheless, consent forms were not received from all parents of participating students. Parents of 181 of the 1,298 students (14 percent) at study camps did not return a consent form and another 72 students of the 1,117 for whom parent consent was collected did not return a completed baseline survey, making the total number of students included in the baseline analytic sample 1,045.

Student Baseline Survey

Prior to the start of camp sessions, all participating camps were mailed copies of the student baseline survey, an administration script for the survey proctor, and pre-paid return shipping labels. Camps also received instruction for administering the baseline survey on the morning of the first day of camp. In total, 1,160 baseline surveys were collected from 1,298 target students. Of the 1,160 submitted surveys 109 were from students for whom parent consent was not obtained and another six were not included in the study because their returned surveys were not complete, resulting in an analytic sample of 1,045 students.

Student Follow-Up Survey

Follow-up surveys were mailed directly to students' homes on October 4, 2013 with a cover letter and return postage paid envelope. The initial deadline for completion was November 15, 2013, although as explained below, the administration period was extended for an additional month (for a total survey fielding period of 11 weeks).

The initial mailings were typically sent to the addresses on file from the parent survey. In advance of the mailing, Lexis/Nexis was used to cross-check and update incomplete addresses. Phone calls were also placed to households with missing or incomplete addresses to obtain updated information prior to the mailing. The student's name was printed on each letter and survey to make clear who the survey respondent should be, which was particularly important when multiple surveys were mailed to the same household (i.e., when multiple children in the same household attended the camp). Consent forms and a different version of the cover letter explaining the necessity of parental consent were included in mailings to a subgroup of parents who had not given prior consent for their student to complete the follow-up survey.

Extensive follow-up activities were conducted over the course of the administration period to maximize response rates. If, due to student mobility, mailings were returned to the study team without a forwarding address, an additional Lexis/Nexis search was conducted to try to identify any alternate addresses and/or phone numbers. Phone calls were also made to these households to attempt to obtain accurate addresses.

One week after the initial mailing, follow-up reminder postcards and email reminders were sent to non-respondent households. Beginning ten days after the initial mailing, ongoing follow-up reminder calls were made to non-respondent households. The reminder calls were also an opportunity to confirm that the surveys were received via mail (and if not, additional copies were mailed) and to confirm the accuracy of the mailing addresses on record. Almost one-third (30 percent) of households were reached via phone over the course of approximately six weeks.

In addition, two weeks after the initial mailing, a second mailing including the cover letter, survey, and a return postage paid envelope was sent to non-respondent households, followed by another email reminder four days later. A third email reminder was sent on October 25.

In an effort to even further improve response rates, in early November the decision was made to develop and administer the follow-up student survey online as an additional option for respondents. On November 12, emails with individual survey links were mailed to parents whose email addresses were on file and whose children had not completed the survey. At that time, subsequent reminder calls to non-respondents also began to collect email addresses from parents interested the possibility of online survey completion and send them individualized links. The deadline for completion was extended to December 6, and a final email reminder was sent to non-respondents four days before the deadline. The online survey was left open for an additional week in order to allow for additional completions. Overall, 636 follow-up surveys were completed; 116 online surveys were submitted and 525 paper surveys were returned.

Non-Response Follow-Up Student Survey Substudy

A substudy was designed to investigate potential non-response bias. Beginning in early January 2014, the study team engaged in an intensive effort to locate and obtain responses from a sample of non-responding students on a subset of items from the original survey (see Appendix I). The non-response follow-up substudy (NRFU) survey was administered via paper, online and telephone to maximize responses.

In advance of the mailing, Lexis/Nexis was used to verify and update home addresses. Phone calls were made to households with incomplete addresses. The student survey was mailed via first-class with a letter and paper copy on January 9, 2014. On January 14, individualized links to the online student survey were emailed to parents with available email addresses. The initial deadline for completion was January 31.

Beginning on January 17, ongoing phone calls were made to offer students the opportunity to complete the survey over the phone, and when that was not possible or desirable, to make sure that parents and/or students had received the paper survey and were aware of the opportunity to complete the survey online. Over one-third (34 percent) of the non-respondent sample was reached over the course of two weeks. Beginning in mid-January, additional calls were also made to alternate phone numbers provided in the parent survey in an effort to obtain accurate phone numbers for non-respondent households.

Additional email reminders including the individualized links to the online student survey were sent to non-respondents on January 21, 27, and 31st. The online survey was left open for an additional ten days to allow for additional completions. In total, 50 of the 144 students included in the NRFU submitted a survey; 27 online surveys were submitted and 23 paper surveys were returned. The NRFU response rate was 35 percent.

Appendix E. Dimensions of Success

The DoS is an observation tool that focuses on 12 dimensions of quality in STEM out-of-school programs, which are grouped into four broader domains—features of the learning environment, activity engagement, STEM knowledge and practices, and youth development in STEM.

Features of the Learning Environment

1. *Organization* reflects the planning and preparation for the STEM activity, and considers the availability of materials used in the activity, the facilitator's ability to adapt to changing situations, and the fluidity of transitions during the session. These features reflect the claim that learning is promoted when the facilitator is well-prepared and uses activity time wisely, avoiding wasted time and maximizing learning opportunities.

2. *Materials* assesses both the appropriateness and appeal of the materials used in the STEM learning activity. The appropriateness of materials is constructed to include the consideration how well matched the materials are to students' abilities as well as the extent to which they suit the learning goals of the activity. This dimension provides important commentary on one feature of the activity, and offers the opportunity to make somewhat minor adjustments to the STEM activity by swapping out the materials if the rating reveals they are not the best option for the audience or activity.

3. *Space utilization* gauges the extent to which the physical space in which the STEM activity is held is conducive to out-of-school- time STEM learning. Rather than "teacher-directed" approaches with desks in rows facing an instructor at the front of the room, informal STEM spaces often have more fluid settings where students have space to move around, discuss with the group, and have appropriate access to materials. A second important feature of the space utilization dimension is the assessment of other distractions (such as noise from a different after-school program) that impede student learning. These elements of the physical activity space contribute to the ability and ease of students' learning.

Activity Engagement

4. *Participation* reflects the extent to which students are visibly and audibly participating in the activities, but does not extend to rating their participation in STEM thinking or inquiry practices (which falls under the inquiry dimension). Instead, participation rates the extent to which students are participating in the activities, following directions, and completing the activities as instructed by the facilitator. An example of a student not participating would be someone "zoning out" or chatting with peers about unrelated topics. Student participation is a key part of their learning experiences, so more successful activities tend to have high levels of student participation.

5. *Purposeful activities* focuses on the structure of the learning activities, measuring the extent to which the students understand the goals of activities and the connections between them, as well as the amount of time spent on activities that relate to the STEM learning goals (versus time spent on other less productive activities). When STEM activities are well-structured, facilitators scaffold student thinking and allow them to deepen their learning.

6. *Engagement with STEM* measures the extent to which students are working in a way that is both "hands-on" and "minds-on", rating both the type of activities as well as the type of learning experience (i.e., passive versus active learning). The goal of this dimension is to tap into students' abilities to construct knowledge for themselves, as opposed to passively watching or listening to a facilitator engage in a STEM activity or demonstrate knowledge.

STEM Knowledge and Practices

7. *STEM content learning* considers the support students receive to build their understanding of STEM concepts through the activities implemented. The dimension includes the consideration of the accuracy of the STEM content presented, the connectedness of the STEM content, and evidence of students' accurate understanding of the concepts (as demonstrated by responses, questions, and conversations).

8. *Inquiry* reflects the use of activities that support STEM practices, such as making observations, asking questions, developing and using models, planning and carrying out observations, analyzing and interpreting data, engaging in argument from evidence, and sharing findings with peers. The use of such practices typically help students learn STEM content more deeply and give them the opportunity to engage with skills pertinent to the daily work of scientists, mathematicians, and engineers.

9. *Reflection* measures the amount of explicit reflection of STEM content during the activity, and the degree to which student reflections are deep and meaningful, supporting connection-building between concepts. For example, activities that ask students to make sense of what they've learned and discuss their ideas with a peer or a larger group allow for reflection.

Youth Development in STEM

10. *Relationships* assesses the nature of the relationship between the facilitator and the students and the students with their peers, gauging from conversations and actions whether or not the interactions suggest warm, positive relationships. Having a positive, respectful relationship helps students and facilitators complete the STEM learning activities to the best of their abilities, couching the experience in a friendly, positive environment that students and facilitators feel comfortable in.

11. *Relevance* focuses on the extent to which the facilitator guides students in making connections between the STEM activities and their own lives or experiences, situating their activity in a broader context. The incorporation of relevance to a STEM activity can help students connect their learning to potential careers and their communities at large.

12. *Youth voice* reflects the ways in which the STEM activity allows students to use their voices and fulfill roles that offer them personal responsibility. The goal is to foster activities in which students' ideas, concerns, and opinions are acknowledged and acted upon by others (within acceptable limits). The opportunity for students to have ownership over the activity and feel like their voices are heard lends itself to a comfortable learning environment where youth can develop as STEM learners.

Appendix F: Teacher Focus Group Protocol

Hello! Thanks so much for coming! My name is [Name], and this is my colleague [colleague name]. We work for Abt Associates/EDC, which is a research firm in Cambridge, MA and Washington, DC. Abt Associates and its partner, Education Development Center (EDC) are conducting an evaluation of NASA's Summer of Innovation. As part of this study, we are talking with teachers who led Summer of Innovation camps to learn about how this year went.

NASA is specifically interested in talking with teachers about these topics:

- *The supports and the challenges faced in implementing SoI curricula*
- *The staff, materials, and NASA resources necessary for successful SoI activities*
- *The plans and preparation necessary for successful program implementation*

Through this focus group discussion, and other information collections, NASA intends to document how SoI was implemented across the nation to better understand what worked and what did not during this summer. The results of this evaluation are intended to ultimately inform future decisions about program requirements and supports.

We expect that our discussion will last about 50 minutes. We will be taking notes during our conversation to ensure accuracy and we would like to audio-tape this conversation, with your permission. No individuals will be identified by name. If you have any further questions that we may not be able to answer about this evaluation or this conversation, please contact Katie Speanburg, Abt Associates' Institutional Review Board Administrator, at (877) 520-6835, or Alina Martinez, the Abt project director of this study at (617) 520-3516. Please note that these are toll calls.

Teacher Focus Group Protocol

1. Warm-Up

- What do you consider your greatest SoI experience so far this summer?

2. Student Activities

- Please describe the student activities/camps this summer. What did a typical day look like for students? [What were the core components of the student activities?]
  - Probe - How similar were the camps you taught? In what ways did the activities differ across camps? Why?
  - Probe - How was NASA curriculum used – alone or in conjunction with non-NASA content? How was the non-NASA content used?
  - Probe – What was most successful about the implementation of the NASA curriculum?
  - Probe – What challenges did you face in implementing the SoI curriculum?
  - Probe - How did you address these challenges?

- Please describe how you plan and prepare for the SoI camps.
  - Probe – Who prepares the overall camp curriculum and is responsible for integrating the SoI content into the overall curriculum?
  - Probe – What challenges have you faced in planning and preparing for camp instruction?
  - Probe - How did you address these challenges?

  - Probe – Do you have any suggestions to improve the planning and preparation for SoI camps?

- Did you have adequate resources to provide SoI experiences?
  - Probe – Was there adequate staffing to maintain a teacher to student ratio of 1 to 20?
  - Probe – Were there adequate materials for SoI activities?
  - Probe – Were there sufficient NASA resources provided for SoI activities?
    - Probe – What resources did NASA provide you with?
    - Probe – Were sufficient NASA curricular materials provided?
    - Probe – Was training provided by NASA staff sufficient?
  - Probe – Do you have any suggestions to improve the support for SoI camps?

3. Professional Development

- Could you describe the training that you received to prepare you to lead SoI camps?
  - Probe – What was the training content? What was the most valuable training that you received?
  - Probe - What did you gain from the PD?
  - Probe - What types of training approaches were used? Were training sessions in person, virtual, hands-on, demonstrations, etc? Did you find that some modalities were more helpful to you than others? Why?
  - Probe - How would you like to see the training and support for teachers improve in the future?

4. Closing

- Do you have any additional thoughts about this summer's SoI activities that we have not discussed?

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Appendix G. Missing Data and Estimating Non-Response Bias

Item Non-Response

Item non-response refers to one or more specific uncompleted items on an otherwise completed/returned questionnaire. When the amount of missing data on an individual item was modest (across all returned surveys), we calculated statistics on only the non-missing items, which is equivalent to an assumption that missing data on an item are missing completely at random.

Where necessary, for analyses where missing data on predictor variables required imputation to prevent having to omit those respondents from the analysis, we used a “dummy-variable” method. This method entails (i) creating a dummy variable that equals “1” if the value of the variable is missing and “0” otherwise, (ii) adding the dummy variable to the impact model as a covariate, and (iii) replacing the missing value of the original variable with zero for non-missing cases.

Unit Non-Response

Unit non-response may pose a problem in analyses as it can potentially introduce bias into population estimates. Bias occurs if students who refuse to participate or leave the study have different characteristics and/or give systematically different responses to the survey (had they responded to it) than the students who complete the surveys. Poor response rates do not guarantee a biased estimate, as the decision to not participate or leave the study could be completely unrelated to survey answers. For the present study, we focused on bias that could occur when students who returned a baseline survey did not return a follow-up survey. As Appendix Exhibit G.1 indicates, among those students who responded to the baseline survey, 605, or 58 percent, responded to the follow-up survey.

Appendix Exhibit G.1 Response Rates

Students with a Baseline Survey (N)	Students with a Baseline and Follow-up Survey (N)	Conditional Response Rate (%)
1045	605	58

Notes: Follow-up surveys were mailed to all 1,298 students in the study sample regardless of if they completed a baseline survey. In total 636 follow-up surveys were received, but only surveys from 605 students could be matched to a baseline survey respondent.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

Given that the response rate fell below 80 percent, we conducted a series of tests to estimate potential bias between responders and non-responders, and correct for it if needed. We refer to students who provided follow-up and baseline surveys as responders and students who provided only baseline surveys as non-responders for the purpose of these checks. Our initial proposed approach to adjust for the probability of a student responding to the follow-up survey was to construct a propensity model that would allow us to differentially weight responders and non-responders in the analysis. Because we proposed that these propensity scores would be based on responder’s demographic characteristics and an enriched sampling frame from the parent survey (about parent degree/work in a STEM field and parent reports of student’s out-of-school STEM activities), we first assessed whether there were any significant differences on the key background variables that would be used in the propensity model. Appendix Exhibit G.2 compares the background characteristics of responders to those of non-responders and indicates that there were no significant differences between the two groups of students on any of the measures with two exceptions: the percentage of 8th graders and the percentage of parents indicating that their children had participated in none of the listed STEM activities in the past 12 months. As the differences are not practically meaningful (four percentage points for 8th grade; 5 percentage points for the activities item), and no other background variables were significantly different, the evaluation team concluded that it was not necessary to differentially weight the two groups.

Appendix Exhibit G.2: Comparison of Responders to Non-Responders

Measure	Students with a Baseline and Follow-up Survey (Responders)		Students with a Baseline Survey Only (Non-Responders)		p-value
	N	Percent	N	Percent	
Grade					
6th	440	37	605	41	0.318
7th	440	28	605	30	0.433
8th	440	25	605	21	0.025
9th	440	10	605	8	0.385
Female	436	44	601	43	0.744
Underrepresented in STEM	429	73	591	69	0.232
Highest Level of Parental Education Completed, Associate's Degree or Higher	411	61	574	63	0.202
Parent has STEM degree or works in STEM field[a]	258	35	365	39	0.231
Parent works in STEM field[a]	253	41	367	44	0.575
Parent reports of children's out-of-school STEM activities					
Science club	425	6	577	7	0.626
Science competition	425	14	577	13	0.622
Science camp	425	15	577	17	0.243
Science study groups or a program where your child was tutored in science	425	8	577	7	0.691
Visiting a science museum, planetarium, or environmental center	425	51	577	53	0.688
Reading science books and magazines	425	55	577	57	0.278
Accessing web sites for computer technology information	425	50	577	51	0.657
Playing games or using kits or materials to do experiments or build things at home	425	49	577	55	0.066
Watching programs on TV about nature and discoveries	425	75	577	76	0.782
None of these	425	11	577	6	<.0001

Notes:
[a]These questions were only asked to parents who indicated they completed an Associate's degree or higher.
Source: Summer of Innovation 2013 Parent Surveys

While the responders and non-responders are similar in terms of their demographic characteristics, they did differ at baseline on the outcomes of interest. Students who did not return follow-up surveys (non-responders) had lower baseline scores on the four outcomes constructs than those that did return follow-up surveys. Thus, it is likely that if non-responders had returned a follow-up survey, their scores on the follow-up constructs would also have been lower than responders' scores. Therefore the missing data is unlikely to be "missing completely at random" (MCAR) and nonimputation is likely to bias the results (Rubin 1976; Rubin 1987).

As expected, after imputation, follow-up averages for each construct were smaller than those calculated solely on students who responded to the follow-up survey (see Exhibit G.3). The results of the models

Exhibit G.3 Estimated Change in Science Engagement Measures, Comparison of Results Using Imputed and Non-Imputed Samples

	Panel A: Imputed Sample						Panel B: Non-Imputed Sample					
	N	Estimated Baseline Mean	Estimated Follow-up Mean	Estimated Difference	Estimated Difference Standard Error	P-Value	N	Estimated Baseline Mean	Estimated Follow-up Mean	Estimated Difference	Estimated Difference Standard Error	P-Value
Enthusiasm for Science scale	1044	3.04	3.14	0.10**	0.027	0.0014	593	3.09	3.23	0.14***	0.028	0.0002
Interest in design and hands-on STEM activities	1041	3.17	3.20	0.04	0.027	0.2119	593	3.21	3.29	0.08*	0.029	0.0152
Interest in out-of-school STEM activities	1037	2.57	2.64	0.07*	0.031	0.0449	597	2.62	2.71	0.08*	0.035	0.0294
General interest in science	1036	3.02	3.09	0.06	0.030	0.0513	586	3.09	3.19	0.10**	0.034	0.0077

Notes: * p<.05, ** p<.01, *** p<.001
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

run on the imputed sample (Panel A in Exhibit G.3) are more likely than the results run on the non-imputed sample (Panel B in Exhibit G.3) to estimates the true change between baseline and follow-up, and therefore are the results presented in this report.

Therefore, to account for missing units in outcome constructs[47]—namely, a follow-up score on one of the primary constructs of interest (e.g., the Enthusiasm for Science scale)—we imputed using a single stochastic regression imputation approach recommended by Puma et al. (2009). In this single imputation approach, a set of values was calculated to replace the missing follow-up score for a given construct. First, predicted values (to replace the missing values) were generated from an OLS regression estimated with data available for all individuals (respondents and non-respondents). Then, to each predicted value, we added a randomly-selected residual from the OLS regression, to account for the inherent uncertainty in predicting missing data. Finally, for those with missing follow-up data, the outcome measures (change scores) were calculated using the regression-predicted follow-up values with random residuals. Because the conditional response rate on the follow-up survey was 58%, a large amount follow-up data on key outcomes was imputed.

Non-Response Bias Study

In addition to testing whether demographic characteristics of responders and non-responders differed, the evaluation team executed a non-response follow-up (NRFU) bias study to assess whether the follow-up responses of non-responders were systematically different from those of responders. Precision calculations conducted before the start of the evaluation using data from the 2011 SoI student surveys[48] indicated that 65 non-responders were needed to estimate a population mean within 5 percentage points of the true population mean (so that the estimated mean would be within ±0.2 points of the actual population mean). To account for lost mail and uncooperative subjects, the evaluation team oversampled the number of non-responders for the NRFU study. One hundred forty five non- responders were randomly sampled using a stratified systematic sampling approach wherein non-responders were first stratified by Awardee/Center and sorted by demographic characteristics, and then randomly selected within strata proportional to the percentage of non-responders at a given site. Of the 145 students sampled for the NRFU study, 50 provided responses (hereafter called *NRFU responders*). Although this is 15 fewer than the original target number, reassessment of the precision calculations using standard deviations from the 2013 Common Instrument follow-up measure indicated that because the variance was smaller than in the 2011 survey, a sample size of 50 was sufficient to maintain a precision of 5 percentage points.

Using the data from the responders to the original survey administration (those with baseline and follow-up surveys; R_1) and NRFU responders (those with baseline and NRFUs surveys; R_2), we estimated the

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47 Recall that for these analyses the outcome is the *difference* between the follow-up and baseline score on a given scale.

48 The precision calculations require an estimate for the amount of variance (standard deviation) for a given construct. To estimate this for the 2013 surveys, we used the 2011 follow-up survey standard deviation on the attitudes towards science scale. Two of the other scales on the 2011 survey were on a 10 to 50 scale, and so standard deviations were too large to use in these calculations, and the fourth scale, which had a 1 to 5 range (interest in NASA-related activities scale), had an almost identical standard deviation (.85) to that of the attitudes towards science scale.

bias for each follow-up measure.[49] To do so, we calculated mean scores for each follow-up measure using only the data from the responding students (R_1) and then calculated an *estimate of the population mean* using data from both responding students and the students who responded to the NRFU survey (R_1 and R_2). Following this, we calculated the difference between the estimates from the first and second steps, which would result in the estimated bias (R_1-R_2). Finally, we divided the bias by the standard error of the mean of the follow-up measure from responding students ((R_1-R_2)/ R_1 standard error). If the bias is small relative to the standard error of responding students (about 0.1 or less of the standard error[50]; Cochran, 1977), no further correction is needed.

Exhibit G.4 presents average follow-up measures for responders, estimated averages for the population using the responder and NRFU data combined, and the estimated bias. As the follow-up means in the two groups indicate, differences between the estimated population mean and the actual responder mean were extremely small. Indeed, the estimated bias for each follow-up measure was equal to or less than one one-hundredth of a point (which is particularly small relative to the range of the scale—one to four). Examination of the estimated bias relative to the standard error of responding students indicates that for three of the follow-up measures, it was well under 0.1.

Appendix Exhibit G.4: Estimated Bias

	Responders (R_1)			All Students (R_1 and R_2)				
Measure	N	Follow-up Mean	Standard Error	N	Estimated Follow-up Mean	Standard Error	Estimated Bias (R_1-R_2)	Estimated Bias Relative to Standard Error of Responding Students (R_1-R_2)/ R_1 standard error
Enthusiasm for Science scale	593	3.22	0.02	1045	3.22	0.02	0.0002	0.0094
Interest in design and hands-on STEM activities	595	3.29	0.03	1045	3.29	0.03	0.0020	0.0732
Interest in out-of-school STEM activities	600	2.66	0.03	1045	2.67	0.03	-0.0119	-0.4289
General interest in science	590	3.19	0.03	1045	3.19	0.03	-0.0016	-0.0492

Notes: Responders are students with baseline and follow-up surveys.
Source: Summer of Innovation 2013 Follow-up Surveys

49 To increase the probability of a high response rate for the NRFU study, several items that were not part of the established Enthusiasm for Science scale were removed from the survey to make it shorter and more palpable for potential respondents. As a result, three items from the interest in out-of-school STEM activities scale and one item in the general interest in science scale were not available for the NRFU responders. Thus, for the purposes of testing bias, these items were also removed from these scales for the larger set of responders (those with baseline and follow-up survey) so that the constructs would be comparable across samples.

50 In other words, if the bias is within the 95% confidence interval the estimate is within the expected range.

While the estimated bias relative to the standard error of responding students was higher than the proposed threshold for the interest in out-of-school STEM activities (-0.429), the evaluation team decided against adjusting for bias on the basis of this measure alone for several reasons. First, the interest in out-of school STEM activities scale, unlike the Enthusiasm for Science scale, was one devised for the purposes of the study, and has not been extensively tested or validated. Thus, we consider the created scales useful for the present study, but acknowledge that the measures are likely not as robust as the Enthusiasm for Science scale. Second, the follow-up means for the responders and the estimated follow-up means for all students were almost identical, and in practical terms, the bias was extremely small (-0.012). In the context of a construct measured on a Likert scale that ranges from one to four, a difference of one-one hundredth is unlikely to move a responder from one category to another. Finally, the direction of the estimated bias was negative, indicating that if the bias is actually present we are *underestimating* the follow-up average by not making any adjustments. Given these considerations, no corrections were made to the data based on the results of the NRFU study.

Appendix H: Measures of STEM Interest and Enthusiasm

Baseline and follow-up student surveys contained 35 items designed to measure STEM interest and enthusiasm.[51] These items were combined to create four constructs measuring different aspects of STEM interest: the Enthusiasm for Science scale (measuring interest and engagement in science), interest in design and hands-on STEM activities, interest in out-of-school STEM activities, and general interest in science at baseline and follow-up. Of the four constructs, the Enthusiasm for Science scale is an existing scale developed by PEAR at Harvard University (see Section 3.3.3 for additional details), and three were created by the evaluation team using factor analysis[52] to group together items that were similarly themed. Appendix Exhibit H.1 presents the Cronbach's alphas[53] at baseline and follow-up for each of the constructs, and the following sections provide additional details about how each construct was created.

Appendix Exhibit H.1 Cronbach's Alphas for SoI Student STEM Interest and Enthusiasm Measures

Measure	Scale's Range	Baseline α	Follow-Up α
Enthusiasm for Science scale	1 to 4	0.92	0.92
Interest in design and hands-on STEM activities	1 to 4	0.78	0.81
Interest in out-of-school STEM activities	1 to 4	0.78	0.85
General interest in science	1 to 4	0.77	0.77

Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

Enthusiasm for Science Scale

Following the methods developed by PEAR, the 19 items comprising the Enthusiasm for Science scale were averaged if students answered at least 70 percent of items included in the scale in the baseline and follow-up surveys, respectively. Items included in the scale were:

- Science is something I get excited about
- I like to take things apart to learn more about them
- I like to participate in science projects
- I'd like to get a science kit as a gift (for example, a microscope, magnifying glass, a robot, etc.)

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51 The surveys included a total of 37 items that could have been combined to create these measures; however, factor analyses determined that two of the items were not sufficiently related to any of the other items to be included in the newly created constructs. These items were, "I would like to have a science or computer job in the future" and "I take science only because it will help me in the future." These items were excluded from analyses and reporting.

52 Factor analysis is a statistical method used to determine underlying relationship between a set of variables. For example, conducting a factor analysis on 10 items related to science may indicate that it is appropriate to group together the five items that focus on science coursework and the five items that focus on science leisure activities.

53 Cronbach's alpha (α) assesses reliability of a rating comprising individual items combined to create a measure the construct. Typically, a Cronbach's alpha above 0.7 indicates that the scale is sufficiently reliable.

- I like to see how things are made (for example, ice-cream, a TV, an iPhone, energy, etc.)
- I like to watch programs on TV about nature and discoveries
- I am curious to learn more about science, computers or technology
- I like to work on science activities
- If I have kids when I grow up, I will take them to a science museum
- I want to understand science (for example, to know how computers work, how rain forms, or how airplanes fly)
- I enjoy visiting science museums or zoos
- I get excited learning about new discoveries or inventions
- I like reading science magazines
- I pay attention when people talk about recycling to protect our environment
- I am curious to learn more about cars that run on electricity
- I get excited to find out that I will be doing a science activity
- I enjoy reading science fiction books
- Science is boring (reverse coded)
- I like science

Interest in Design and Hands-On STEM Activities Scale

Four items were averaged together to create the interest in design and hands-on STEM activities scale. In order for the measure to maintain its reliability, sensitivity analyses determined that students had to answer at least half of the items in the scale on the baseline and follow-up surveys, respectively. The following items were included in the scale:

- I like to design a solution to a problem
- I like to be part of a team that designs and builds a hands-on project
- I'm curious to learn how to program a computer game
- I like to design and build something mechanical that works

Interest in Out-Of-School STEM Activities Scale

Nine items were averaged together to create the interest in out-of-school STEM activities scale. In order for the measure to maintain its reliability, sensitivity analyses determined that students had to answer at least half of the items in the scale on the baseline and follow-up surveys, respectively. The following items were included in the scale:

- Since [reference period[54]] how often have you done the following science activities:
  - Read science books and magazines
  - Access web sites for computer technology information
  - Visit a science museum, planetarium, or environmental enter
  - Play games or use kits or materials to do experiments or build things at home
  - Watch programs on TV about nature and discoveries
- I like learning about science on the internet
- I like online games or computer programs that teach me about science
- I do science-related activities that are not for schoolwork
- Before joining this program, I participated in science activities outside of school

General Interest in Science Scale

Three items were averaged together to create the general interest in science scale. In order for the measure to maintain its reliability, sensitivity analyses determined that students had to answer at least two-thirds of the items in the scale on the baseline and follow-up surveys, respectively. The following items were included in the measure:

- Before joining this program, I was interested in science and science-related things
- Science is one of my favorite subjects
- I take science only because I have to (reverse coded)

[54] The reference period on the baseline survey was "beginning of the last school year (2012-2013)" and the reference period on the follow-up survey was "since you participated in Summer of Innovation."

Appendix I: Nonresponse Substudy Student Survey

Summer of Innovation Youth Follow-Up Survey

Last summer you participated in NASA's Summer of Innovation also called SoI! We hope you will answer a few questions that will help improve this program for the future. There are no "right" or "wrong" answers to any of the questions. We want your honest opinions.

When you registered for SoI, your parent said it is ok for you to answer these questions. However, your participation is voluntary—you may choose not to answer a question or to stop answering the questions at any point. It should take about 5 minutes to complete the questions. Your answers will help us learn about students' interest in science, math and engineering, and help us improve NASA programs. Thank you very much for your help!

NASA and its research team follow strict rules to make sure that only they will see your answers to these and other questions about SoI, except as required by law. No report will use your name or describe you in any way that could identify you.

If you wish to participate in this survey, please continue.

<u>Return your completed survey in the self-addressed stamped envelope.</u>

Today's Date: Month ___ Day __ Year ______

Tell NASA about yourself

1. Your first name: ______________________Your last name: ______________________________

2. What is your birthday (MM/DD/YEAR)?: Month: ___ Day:___ Year: ______

3. What grade level did you begin in fall 2013?

❑ 4th ❑ 5th ❑ 6th ❑ 7th ❑ 8th ❑ 9th ❑ Other: _____

Science activities in and outside of school

4. Which of the following activities are you participating in during this school year (2013-2014)? Check all that apply.
   - ❑ Science club
   - ❑ Science competition
   - ❑ Science camp, not including Summer of Innovation
   - ❑ Science study groups or a program where you were tutored in science
   - ❑ None of these

5. Since you participated in the Summer of Innovation, how often have you done the following science activities?

Activity	Never	Rarely	Sometimes	Often
a. Read science books and magazines	1	2	3	4
b. Access web sites for computer technology information	1	2	3	4
c. Visit a science museum, planetarium, or environmental center	1	2	3	4
d. Play games or use kits or materials to do experiments or build things at home	1	2	3	4
e. Watch programs on TV about nature and discoveries	1	2	3	4

Opinions about science

The next series of questions contain a number of statements about science. You will be asked what you think about these statements. There are no "right" or "wrong" answers. We just want your opinions. For this survey, the word "science" covers a broad range of topics, including space and planets, animals and plants, medicine, computer programming, and designing things like machines.

6. Please indicate the extent to which you agree or disagree with each of the following statements. Select ONE in each row.

	Strongly Disagree	Disagree	Agree	Strongly Agree
a. Science is something I get excited about	1	2	3	4
b. I like to take things apart to learn more about them	1	2	3	4
c. I like to participate in science projects	1	2	3	4
d. I'd like to get a science kit as a gift (for example, a microscope, magnifying glass, a robot, etc.)	1	2	3	4
e. I like to see how things are made (for example, ice-cream, a TV, an iPhone, energy, etc.)	1	2	3	4
f. I like to watch programs on TV about nature and discoveries	1	2	3	4
g. I am curious to learn more about science, computers or technology	1	2	3	4
h. I like to work on science activities	1	2	3	4
i. If I have kids when I grow up, I will take them to a science museum	1	2	3	4
j. I would like to have a science or computer job in the future	1	2	3	4
k. I want to understand science (for example, to know how computers work, how rain forms, or how airplanes fly)	1	2	3	4
l. I enjoy visiting science museums or zoos	1	2	3	4
m. I get excited about learning about new discoveries or inventions	1	2	3	4
n. I like reading science magazines	1	2	3	4
o. I pay attention when people talk about recycling to protect our environment	1	2	3	4
p. I am curious to learn more about cars that run on electricity	1	2	3	4
q. I get excited to find out that I will be doing a science activity	1	2	3	4
r. I enjoy reading science fiction books	1	2	3	4
s. Science is boring	1	2	3	4

	Strongly Disagree	Disagree	Agree	Strongly Agree
t. I do science-related activities that are not for schoolwork	1	2	3	4
u. I like science	1	2	3	4
v. Science is one of my favorite subjects	1	2	3	4
w. I take science only because I have to	1	2	3	4
x. I take science only because it will help me in the future	1	2	3	4
y. I like to design a solution to a problem.	1	2	3	4
z. I like to be part of a team that designs and builds a hands-on project.	1	2	3	4
aa. I'm curious to learn how to program a computer game.	1	2	3	4
bb. I like to design and build something mechanical that works.	1	2	3	4

Thanks for taking the time to complete this survey!

Return your completed survey in the self-addressed stamped envelope.

Appendix J: Estimated Effect Sizes

Exhibit J.1: Estimated Effect Sizes for Science Engagement Measures

	N	Estimated Effect Size	P-Value
Enthusiasm for Science scale	1044	0.12	0.001
Interest in design and hands-on STEM activities	1041	0.04	0.212
Interest in out-of-school STEM activities	1037	0.07	0.045
General interest in science	1036	0.07	0.051

Notes: * p<.05, ** p<.01, *** p<.001
Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

Exhibit J.2: Estimated Effect Sizes for the Relationships between Student Characteristics and Science Engagement Measures

	Enthusiasm for Science scale (n=1044)		Interest in design and hands-on STEM activities (n=1041)		Interest in out-of-school STEM activities (n=1037)		General interest in science (n=1036)	
	Effect Size	P-Value	Effect Size	P-Value	Effect Size	P-Value	Effect Size	P-Value
Female	-0.02	0.431	0.02	0.618	0.01	0.766	0.04	0.232
Grade	0.04	0.156	-0.01	0.754	0.04	0.235	0.03	0.299
Underrepresented in STEM	0.06	0.043	0.00	0.975	0.07	0.021	0.05	0.116
Parental Education - Associate's Degree or Higher	0.11	0.001	-0.01	0.861	0.06	0.060	0.03	0.346

Notes: * p<.05, ** p<.01, *** p<.001

Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys

Exhibit J.3: Estimated Effect Sizes for the Relationships between Camp Characteristics and Quality and Science Engagement Measures

	Enthusiasm for Science scale		Interest in design and hands-on STEM activities		Interest in out-of-school STEM activities		General interest in science	
	Effect Size	P-Value	Effect Size	P-Value	Effect Size	P-Value	Effect Size	P-Value
Camp Characteristics	**(n = 1044)**		**(n = 1041)**		**(n = 1037)**		**(n = 1036)**	
Percentage of certified K-12 teachers	0.02	0.4932	0.06	0.0612	0.09	0.0053	-0.01	0.6963
Percentage of students attending at least half of camp session	-0.01	0.6667	0.02	0.5040	-0.08	0.0113	0.04	0.2267
Educator-student ratio[a]	0.08	0.0148	0.04	0.2378	0.05	0.1202	0.12	0.0002
Dimensions of Success	**(n=834[b])**		**(n = 831[b])**		**(n = 829[b])**		**(n = 826[b])**	
Percent of 3 or 4 ratings on dimensions[c]	0.13	0.0002	0.08	0.0178	0.11	0.0011	0.01	0.8610

Notes: * p<.05, ** p<.01, *** p<.001
Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures.
[a]Educator-Student ratio as reported by camps. Higher numbers indicate that there were more educators per student.
[b]Classroom observations were only conducted in eight of the 11 sites represented in the student surveys, reducing the sample size for these analyses.
[c]Two classrooms per camp were observed on two different days. Therefore, all camps had four observations. To aggregate across observations, we calculated the percentage of the four observations that were rated a 3 or 4 across all dimensions.
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys. Summer of Innovation 2013 Performance Data; Summer of Innovation 2013 Dimensions of Success Data.

Appendix K: Change in Student Engagement and DoS Camp Quality Dimensions

Exhibit J.1: Estimated Effects of DoS Camp Quality Dimensions on Change in Science Engagement Measures

Percent of observations rated a 3 or 4[b]	Enthusiasm for Science scale (n = 834a)			Interest in design and hands-on STEM activities (n = 831a)			Interest in out-of-school STEM activities (n = 829a)			General interest in science (n = 826a)		
	Estimated Effect	Estimated Effect Standard Error	P-Value	Estimated Effect	Estimated Effect Standard Error	P-Value	Estimated Effect	Estimated Effect Standard Error	P-Value	Estimated Effect	Estimated Effect Standard Error	P-Value
Features of the learning environment												
Organization	0.001	0.001	0.0660	0.001	0.001	0.3034	**0.002*** **	0.001	0.0004	0.000	0.001	0.7680
Materials	**0.001***	0.001	0.0226	0.001	0.001	0.2306	**0.002****	0.001	0.0024	0.000	0.001	0.7343
Space utilization	**0.001***	0.001	0.0144	0.001	0.001	0.0553	**0.002*** **	0.001	0.0009	0.000	0.001	0.8265
Activity engagement												
Participation	0.002	0.002	0.2756	0.002	0.002	0.4553	**0.004***	0.002	0.0492	0.000	0.002	0.8408
Purposeful activities	**0.002***	0.001	0.0230	0.001	0.001	0.3930	**0.003*** **	0.001	0.0004	0.001	0.001	0.5932
Engagement with STEM	**0.003***	0.001	0.0100	**0.003***	0.001	0.0107	0.002	0.002	0.2535	0.002	0.001	0.0713
STEM knowledge and practices												
STEM content learning	**0.002****	0.001	0.0077	**0.002***	0.001	0.0124	0.001	0.001	0.6845	**0.002***	0.001	0.0328
Inquiry	0.001	0.001	0.1156	**0.002****	0.001	0.0056	**0.002***	0.001	0.0371	0.000	0.001	0.7597
Reflection	0.001	0.001	0.1597	0.001	0.001	0.2007	0.001	0.001	0.1076	-0.001	0.001	0.1410
Youth development in STEM												
Relationships	0.003	0.003	0.2351	0.003	0.004	0.4457	0.002	0.004	0.4799	-0.002	0.004	0.5143
Relevance	**0.002***	0.001	0.0196	0.000	0.001	0.9200	0.002	0.001	0.1235	0.000	0.001	0.7462
Youth voice	**0.002*** **	0.000	0.0002	**0.002***	0.001	0.0109	0.001	0.001	0.0982	0.000	0.001	0.9527

Notes: * p<.05, ** p<.01, *** p<.001
Depending on the outcome, data were imputed for the 431 to 439 students with baseline data but no follow-up measures.
aClassroom observations were only conducted in eight of the 11 sites represented in the student surveys, reducing the sample size for these analyses.
bTwo classrooms per camp were observed on two different days. Therefore, all camps had four observations. To aggregate across observations, we calculated the percentage of the four observations that were rated a 3 or 4 within each dimension
Source: Summer of Innovation 2013 Student Baseline and Follow-up Surveys. Summer of Innovation 2013 Dimensions of Success Data.

References

Ault, P. C. (2005). *Annual report: Salmon Camp Research Team*. Portland, OR: Oregon Museum of Science and Industry.

Cochran, W.G. (1977). Sampling Techniques. 3rd edition. John Wiley & Sons, New York.

Cohen, J. (1969). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, J. (1988). Statistical Power Analysis for Behavioral Sciences. Hillside, NJ: Lawrence Erlbaum.

Crombie, G., Walsh, J.P., et. al. (2003). Positive effects of science and technology summer camps on confidence, values, and future intentions. *Canadian Journal of Counselling*, 37(4), 256-269.

Dave, V., Blasko, D., Holliday-Darr, K., Kremer, J. T., Edwards, R., Ford, M., et al. (2010). Re-enJEANeering STEM education: Math options summer camp. *The Journal of Technology Studies*, 36, 35-45.

Ferry, N. (2006). Factors influencing career choices of adolescents and young adults in rural Pennsylvania. *Journal of Extension 44,* 3 (June 2006).

Fournier, R., DeLisi, J., & Levy, A.J. (2011). *NASA Summer of Innovation (SoI): Informal science education and student engagement.* Newton, MA: Education Development Center, Inc.

Goldstein, D. (2008). *The evaluation of COSMOS (2000-2008): Developing future scientists, engineers, and mathematicians*. Berkeley, CA: Lawrence Hall of Science, Center for Research, Evaluation and Assessment, University of California. Retrieved July 1, 2011 from http://www.ucop.edu/cosmos/documents/eval_report.pdf

Harvard Family Research Project. (n.d.). *A profile of the evaluation of Girls Incorporated—Thinking SMART Program*. Cambridge, MA: Author. Retrieved July 27, 2011, from http://hfrp.org/out-of-school-time/ost-database-bibliography/database/girls-incorporated-thinking-smart-program

Harvard Family Research Project. (n.d.). *A profile of the evaluation of SECME RISE (Raising Interest in Science & Engineering)*. Cambridge, MA: Author. Retrieved July 27, 2011, from http://hfrp.org/out-of-school-time/ost-database-bibliography/database/secme-rise-raising-interest-in-science-engineering

Hayden, K., Ouyang, Y., Scinski, L., Olszewski, B. & Bielefeldt, T. (2011). Increasing student interest and attitudes in STEM: Professional development and activities to engage and inspire learners. Contemporary Issues in Technology and Teacher Education, 11(1), 47-69.

Hossler, D., Schmidt, J. & Vesper, N. (1999). *Going to college: How social, economic, and educational factors influence the decisions students make*. Baltimore: The Johns Hopkins University Press.

Kish, L. (1965). *Survey Sampling*. New York: John Wiley & Sons, Inc.

Jarrett, O.S., & Burnley, P.C. (2007). The role of fun, playfulness, and creativity in science: Lessons from geoscientists. In D. Sluss & O. Jarrett (Eds.) *Investigating play in the 21st Century: Play and Culture Studies, Vol. 7* (pp. 188-202). Lanham, MD: University Press of America.

Kegan, T. R. (1989). How Charles Darwin became a psychologist. In D. B. Wallace & H. E. Gruber (Eds.), *Creative people at work: Twelve cognitive case studies* (pp. 107-126). New York: Ox-ford University Press.

Martinez, A., Brooke, N., & Linkow, T. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Documentation of Performance Data*. Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA

Martinez, A., Linkow, T., Brooke, N., DeLisi, J., & Levy, A. J. (2013). *Evaluation Study of Summer of Innovation Stand-Alone Program Model FY 2013: Implementation Report.* Report prepared for the National Aeronautics and Space Administration. Abt Associates, Cambridge, MA. Available http://www.nasa.gov/offices/education/performance/index.html

McDonough, P. M. (1997). *Choosing colleges: How social class and schools structure opportunity*. Albany: State University of New York Press.

Merrill, C., Custer, R. L., Daugherty, J., Westrick, M., & Zeng, Y. (2008). Delivering core engineering concepts to secondary level students. The Journal of Technology Education, 20, 48-64.

Minner, D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—What is it and does it matter? Results from a research synthesis. Journal of Research in Science Teaching, 47(4), 474-496.

National Institute on Out-of-School Time. (2007). *A Review of the Literature and the INSPIRE Model: STEM in Out-of-School Time*. Wellesley, MA: Wellesley College.

Nugent, G., Barker, B., et al. (2010). Impact of robotics and geospatial technology interventions on youth STEM learning and attitudes. *The Journal of Research on Technology in Education*, 42(4), 391-408.

Puma, M.J. Olsen, R.B., Bell, S.H., and Price, C. (2009). What to Do When Data Are Missing in Group Randomized Controlled Trials. U.S. Department of Education, Washington DC. NCEE 20090049 (available http://ies.ed.gov/pubsearch/pubsinfo.asp?pubid=NCEE20090049).

Raudenbush, S. W. & Bryk, A. S. (2002). Hierarchical linear models: Applications and data analysis methods. Newbury Park: Sage Publication.

Rowsey, R.E. (1997). The effects of teachers and schooling on the vocational choice of university research scientists. *School Science and Mathematics*, *97*(1), 20-27.

Shepard, R. (1988). The imagination of the scientist. In K. Egan & D. Nadaner (Eds.), *Imagination across the curriculum* (pp.153-185). New York: Teachers College Press.

Sirinterlikci, A., Zane, L., & Sirinterlikci, A. L. (2010) Active learning through toy design and development. *The Journal of Technology Studies*, 35, 14-22.

Swail, W. S. & Hosford, S. (2007). *Missouri students and the pathway to college.* Virginia Beach, VA: Educational Policy Institute.

Tai, R. (2014). The Long-Term Impact of Out-Of-School STEM Learning Opportunities on Children and Youth. Presented at *American Association for the Advancement of Science Annual Conference*, February, 12-17, 2014.

Trice, A. D., Hughes, M. A., Odom, C., Woods, K., McClellan, N. C. (1995). The origins of children's career aspirations: IV. Testing hypotheses from four theories. *The Career Development Quarterly 43*, 4 (June 1996), 307-322.

Tripney, J., Newman, M., Bangpan, M., Niza, C., MacKintosh, M., & Sinclair, J. (2010). *Factors influencing young people (aged 14-19) in education about STEM subject choices: A systematic review of the UK literature*. London: EPPI-Centre, University of London.