



NASA's Summer of Innovation in the Rio Grande Valley: Does summer STEM engagement increase student interest and teacher instruction among under-represented and underserved youth?

Ms. Margaret Baguio, University of Texas at Austin

Margaret Baguio is the Senior Education and Outreach Coordinator for NASA's Texas Space Grant Consortium at The University of Texas at Austin's Center for Space Research. She has over 30 years education experience including classroom teaching, as a 4-H and Youth Extension Agent for the Texas Agri-life Extension Service, managed a USDA Science and Literacy grant for underrepresented and underserved youth, and provides space education programs for teachers at students in her current position with Texas Space Grant Consortium. She has a Bachelor of Science degree from Texas State University, post-graduate work at Texas A & M University and a Masters in Education from The University of Houston.

Dr. Wallace T. Fowler P.E., University of Texas, Austin

Dr. Wallace Fowler has served on the faculty of the Department of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin since 1965. His early research focused on low thrust interplanetary trajectory optimization. In the 1970s, his research focus broadened to include spacecraft attitude dynamics, tumbling satellite dynamics and retrieval, spacecraft rendezvous and proximity operations, and spacecraft / mission design. His current research centers on spacecraft / mission design and space systems engineering.

Dr. Fowler's has received over a dozen local, regional, and national teaching awards. He is a Fellow of both the ASEE and the AIAA. He is a member of the University of Texas Academy of Distinguished Teachers. He served as President of ASEE in 2000-2001. He was the recipient of the 1985 AIAA/ASEE John Leland Atwood Award and the 1994 ASEE Fred Merryfield Design Education Award. He currently directs the NASA Texas Space Grant Consortium.

Mrs. Susana Ramirez, PSJA ISD

Susana Ramirez is the Elementary Science Coordinator for PSJA ISD. She is currently in her 13th year with the district. She serves as the Grant Coordinator for the Rio Grande Valley Science Association and is a member of numerous professional organizations including National Science Teacher Association, Science Teacher Association of Texas, Texas Council of Elementary Science, Texas Science Education Leadership Association and NASA Texas Space Grant. Other honors: Mentor Teacher of the Year for the state of Texas in 2005. Teacher of the Year at her campus in 2008 and received the Toyota Excellence Science Teacher of the Year in 2008. In 2009 she was named Texas Elementary Science Teacher of the year by the Texas Medical Association. She is an alumni for NASA LiftOff and a NASA Heliophysics Ambassador.

Dr. Judit Györgyey Ries, The University of Texas

Judit Györgyey Ries is a Research Associate at the University of Texas/McDonald Observatory, and at the Center for Space Research. She received her undergraduate Astronomy degree at the Eötvös University in Hungary. She has an M.S. in Aerospace Engineering and a PH.D. in Astronomy from the UT at Austin. She has worked with the McDonald Observatory Lunar Laser Ranging, and in 1997 she joined the Small Solar System Objects project conducting astrometry for orbit determination of Near Earth Asteroids candidates. She is also collecting and analyzing light curves to determine physical characteristic. She is also actively involved in Public Outreach, giving talks to wide range of audiences from elementary school children to retirees and amateur astronomers. With colleagues at the Center for Space Research she has conducted many Astronomy and Space Science workshops for teachers to help implementing the new Texas Science curriculum.

**NASA’s Summer of Innovation in the Texas Rio Grande Valley:
Does summer STEM engagement increase student interest and teacher instruction among
underrepresented and underserved youth? - Program Evaluation**

Abstract:

This paper demonstrates the success of the Summer of Innovation program over a four year period and answers the question “Does summer STEM engagement increase student interest and teacher instruction among underrepresented and underserved youth?”

Summer and after-school programs present a prime venue for fostering student interest in Science, Technology, Engineering, and Mathematics (STEM) because of their informal atmosphere and their unique ability to inspire and excite children through enrichment experiences and hands-on, project-based group activities. Out-of-school time (OST) activities allow students to connect with STEM on a personal level, which is especially important for students who are underrepresented in these fields and may not have previously felt encouraged to pursue STEM. Summer of Innovation (SoI) was designed to give students an opportunity to engage in OST learning at an early age and during a critical period in the education cycle: summer. While professionals in STEM may attribute their decision to pursue STEM careers to an out-of-school experience, many formal and informal educators do not feel they have the skills and knowledge to successfully engage youth in programs to positively impact STEM learning.

In 2009, President Obama announced the “Educate to Innovate” campaign to foster a renewed commitment to strengthen Science, Technology, Engineering, and Math (STEM) education. In January 2010, the National Aeronautics and Space Administration (NASA) launched the Summer of Innovation (SoI) project in response to the President’s call to action. SoI’s clearly articulated Vision, Mission, and Objectives are centered on building local educational capacity for supporting STEM education for underserved and underrepresented middle school students.

This paper examines the SoI program in the Lower Rio Grande Valley of south Texas and its role in exciting students in engineering education. SoI is geared specifically towards underserved and underrepresented students in grades 4-9 and leverages a multi-faceted, partnership-based implementation approach to maximize the project’s scale and research while allowing for local flexibility and innovation. By identifying local needs of schools and providing sustained professional development to certified educators in support of effective content delivery, we increase capabilities of summer programs to provide program models that are viable for replication or scalability of student interventions.

Specific questions addressed in this report ask:

1. Do summer Science, Technology, Education, and Math (STEM) engagement activities increase student interest in STEM?
2. Did participating teachers gain knowledge, build critical instructional skills, and increase self-confidence in motivating students in STEM?
3. Did participating students gain STEM knowledge and become excited about moving forward in the STEM education and career pipeline?

4. What are participating teachers' and students' opinions about their experience in the activities provided through this project?

NASA Summer of Innovation

Background: In 2009, President Obama announced the “Educate to Innovate” campaign to foster a renewed commitment to strengthen Science, Technology, Engineering, and Math (STEM) education. In January 2010, the National Aeronautics and Space Administration (NASA) launched the Summer of Innovation (SoI) project in response to the President’s call to action. SoI’s clearly articulated Vision, Mission, and Objectives are centered on building local educational capacity for supporting STEM education for underserved and underrepresented middle school students.

Vision: Advance excellence in summer and extended learning for underrepresented and underserved middle school students to inspire them toward future STEM pursuits.

Mission: Strengthen efforts by providers that engage underrepresented and underserved middle school students in STEM learning by using exciting and rigorous NASA-based instructional resources, experiences and support tailored to local needs.

Objectives:

- Build the capacity of community- and school-based organizations to engage underserved and underrepresented students in high-quality STEM content, focusing on the “E” in summer and extended learning experiences tailored to meet local needs.
- Support the infusion of NASA themes and engineering resources in summer and extended learning.
- Facilitate the alignment of summer and extended learning programming with the formal education community to support coordinated and sustained engineering engagement in STEM content.

Summer and after-school programs present a prime venue for fostering student interest in STEM because of their informal atmosphere and their unique ability to inspire and excite children through enrichment experiences and hands-on, project-based group activities.¹ Out-of-school time (OST) activities allow students to connect with STEM on a personal level, which is especially important for students who are underrepresented in these fields and may not have previously felt encouraged to pursue STEM.² SoI was designed to give students an opportunity to engage in OST learning at an early age and during a critical period in the education cycle: summer. As a recent study has shown, 75% of Nobel Prize winners in science attribute their interest in science to an out-of-school experience,³ and many students who originally underachieved in STEM before successfully pursuing STEM careers discovered their passion during OST programs.⁴ A meta-analysis of 93 summer program evaluations showed that summer programs designed to improve students’ academic abilities tend to increase skills and knowledge by the end of the summer. (Coper)⁵ In fact, not attending summer programs can have negative impacts on student performance. While students are on summer break, many forget what they learned in the previous year and enter the next grade at a disadvantage. Because of this “summer slide,” the average student loses around two months of math skills by the end of the summer.⁶

Implementation

“Imagine Now to Innovate for the Future” was one of seven national awardees for NASA Summer of Innovation and was designed to train a select set of certified middle school teachers from school districts throughout the Lower Rio Grande Valley (LRGV) of South Texas to disseminate mission information and use NASA-themed experiences to excite Grade 4-9 students about science, technology, engineering, and math (STEM). Through partnership with the Texas Education Agency's Region One which is comprised of 37 school districts and 24 charter school campuses, NASA's Texas Space Grant Consortium, and The University of Texas at Austin, teachers in 7 counties along the US-Mexico border were provided the opportunity to learn methods for incorporating NASA curriculum that used actual human space flight information, satellite data, grade-level appropriate classroom activities, and hands-on instruction related to the four facets of STEM education. Teachers who participated in the training then infused NASA content and products into project-based STEM summer camps and school enrichment activities for females, minorities, and low-income students entering grades 4-9.

Annual objectives for this four-year project funded by a grant from NASA included:

- 150 certified teachers annually will increase their knowledge of NASA's scientific and engineering achievements and products supporting STEM education and learn about the importance of introducing students to diverse science careers and scientists of those fields during Texas Summer of Innovation (SoI) professional development training which will prepare them to lead summer student experiences and classroom activities during the school year.
- 2,500 underrepresented and underserved middle school students annually will participate in a minimum of 30 hours of SoI activities during the summer while increasing their STEM knowledge during a suite of SoI activities.
- Project-based learning activities were implemented during the summer at local schools and Boys and Girls Club sites with a minimum of 30 contact hours per student. These summer programs were followed during the school year with after-school STEM engagement, Science Saturdays, Family Science Nights, and STEM classroom activities conducted by teachers during regular school hours.

With NASA support and detailed content, SoI strategically partnered with 13 school districts and community-based youth organizations annually. The schools recruited certified teacher's, provided free breakfast and lunch for participants, opened school facilities and staff for the camps, and provided bus transportation to and from the school. Youth organizations recruited staff to implement activities and provided facilities for hosting the camps. The project team selected NASA curriculum and activities from the NASA Summer of Innovation website (<http://www.nasa.gov>)⁷, coordinated camp schedules, conducted the training, purchased all materials, and managed the program logistics.

Each year, the program management team met with local school district and youth organization representatives to select camp themes, coordinate training dates, and discuss implementation strategies. Changes made were based on evaluation results. NASA themes were selected from offerings suggested on the NASA Summer of Innovation website for teacher training along with

summer camp activities to increase capabilities and interest in STEM studies and careers. The partnerships and activities that bring regional STEM stakeholders together to create stimulating STEM learning communities will sustain the effort to increase diversity and equity in the STEM education and career pipeline.

Camp themes included Girls in Science, Light and Optics, Solar System Exploration, Let’s Engineer It, Underwater Robotics, Rocketry, and Living in Space. While each camp theme began with the engineering design process which applied to all activities, four themes were selected each year. In Year 1, students were recruited for the camps by flyers distributed at the schools, signage in schoolyards declaring “NASA is coming!” and through public service announcements advertised on the local cable television. In following years, Family Science Nights were hosted in the school districts where camps would be held. Students and an invited guest came to the school and rotated through hands-on activities in each of the camp themes that would be offered, and had the opportunity to register their student for the summer program.

Numbers Reached			
Year 1	2,691 youth	151 teachers	
Year 2	2,497 youth	134 teachers	
Year 3	2,617 youth	115 teachers	25 informal
Year 4	2,270 youth	83 teachers	22 informal

Logistics The trainer for each camp theme selected the activities that would be included in the camp, provided suggested time for each activity, selected NASA support videos links, and made a list for needed supplies. Because the project purchased all materials and provided them to the teachers, shopping and transporting became a critical part of the implementation success. The PI and Co-PI had to take the shopping list, identify whether the activity was an individual or group activity, determine how many sites would be offering this camp, and then multiply to get totals of items to be purchased. Doing camps for 1,500 youth, with each camp having 10-15 activities, was a shopping and transportation challenge. A storage room was rented to store materials close to the sites and vans were rented by partners six hours away to transport goods.

Teacher participants were paid for their professional development and for the camp implementation. To insure that each teacher (camp leader) provided the necessary information NASA required in their evaluation, a Teacher Contract was developed after year 1. The contract included a minimum number of students in each camp, attendance lists, quotes from students and parents, and photos or a video of their camp implementation. Teachers were not paid until all elements were turned in to the coordinators of each district.

Initially, the grant was written that as funds reduced each year, school districts would realize the benefit of the summer engagement and pay teachers to participate. While school districts agreed and were enthusiastic, their budgets were cut and they had no funds to contribute. Since the number of students to be reached remained the same annually, the program partnered with the Boys and Girls Clubs throughout the region. Their informal education staff members are

employees of the Boys and Girls Clubs so no salary was needed. We trained their staff during the Boys and Girls Club Staff State Conference and provided materials for implementation.

Evaluation Methods Data sources for the evaluation of the project were: (1) survey feedback from convenience sampling of teachers in the summer workshops and (2) students' responses to surveys their teachers administered during summer camps.

Evaluation Methodology

Evaluation Questions	Data Sources	Data Evaluation Methods
1 What NASA themes were selected for LRGV SoI activities during the project?	Teachers' and students' self-reports of NASA theme of the summer camps 2011 and 2012	Description of percentages of participating teachers and students by theme
2a Did teacher training activities reach the planned diversity of certified teachers?	Participants' responses to workshop questionnaire demographic items	Comparison of diversity against the plan and against published data on diversity of teachers statewide
3. Did participating teachers gain knowledge, build critical instructional STEM skills, and increase self-confidence in motivating students in STEM?	Retrospective/Post-Then survey administered at the close of the teacher training workshop spring 2011 plus rapid response feedback from participants in teacher training workshop spring 2012	Comparison against criterion reference Comparison of pre- with post-workshop responses
2b. Did the summer camp activities reach the planned diversity of students?	Students' self-reports to their teachers in summer camps 2012	Comparison against criterion references extracted from the project plan
4. Did participating students gain STEM knowledge and become excited about moving forward in the STEM pipeline?	Students' responses to surveys administered by their teachers in summer camps 2012	Criterion references for knowledge gain, intentions for further STEM education, and career interests
5. What are participating teachers' and students' opinions about their experience in the activities provided through the LRGV SoI project?	Participants' written feedback provided in response to open-end survey questions that requested their opinions	Qualitative analysis

Program Purpose and Objectives

In 2011, NASA administered an external evaluation that included surveys of teachers and students. Due to changes in the protocol, NASA elected not to administer any evaluations in 2012. While not a requirement for the LRGV SoI project, RGVSA continued with its plan for local evaluation.

Primary data sources for this evaluation of the project were: (1) survey responses from convenience samples of teachers who participated in the summer workshops; (2) students' responses to surveys their teachers administered in summer camps; and (3) interviews with project leaders.

The RGVSA survey questionnaires for teachers were produced in consultation with the project's principal investigators by adapting selected items from the "Mathematics and Science Teacher

Questionnaires” from the NSF supported 2000 National Survey and tailoring the questions to the specific topics and activities of the LRGV SoI "Imagine..." project.

The summer camp teachers who participated in the project's teacher training activities administered anonymous surveys to their students at the close of the summer camps. The surveys addressed the specific inquiry-guided activities for the given camp and also included questions suggested in descriptions of goals and expected outcomes described in the project proposal and on the NASA Summer of Innovation website.

The downloaded datasets compiled from Survey Monkey were further analyzed to address the evaluation questions in the current report using the Statistical Package for the Social Sciences (SPSS) version 21.

Sources of criterion references used in the current evaluation are from (a) project expectations and objectives cited in the proposal to NASA dated 2010; (b) two science teaching status reports available online. These latter reports--“The Status of Secondary Earth Science Teaching” dated 2002 but based on data from the 2000 National Survey conducted by Horizon Research for the National Science Foundation (NSF)⁸ and reports published by the Texas Education Agency (TEA) in May 2012⁹ describing demographics and teaching experience of science teachers Statewide--were selected as sources of criterion references because they provided the most recent information available in online search of reports accessible to the public.

NASA conducted an in-depth evaluation of this program however the results have not been published. The project evaluator was Dr. Cindy Roberts-Gray of Third Coast Research and Development. Random sampling of participants and results of the evaluation are as follows:

NASA Themes Selected for Project Activities

Camp Themes	Number of Teacher Training Participants Responding to the Survey		Number of Student Participants Responding to the Survey Summer 2012 (N=639)
	Summer 2011 (N=140)	Summer 2012 (N=23)	
Girls in Science	38	8	192
Astronomy/Solar System	24	4	160
Engineering/Robotics	38		170
Rocketry	37	11	132

NASA themes for the summer camps whose teachers conducted student surveys in the summer of 2012 included Girls in Science-Light & Optics, Solar System Adventures, Engineering, Underwater Robotics, and Rocketry. Certified teachers for camps with these themes participated in LRGV SoI training in the summer of 2011 and/or Summer of 2012. A total of 32 of the camps participated in the student surveys:

- 8 "Girls in Science" camps (survey respondents ranged from 8 to 32 per camp with median = 21);
- 9 "Solar System Adventures" camps (survey respondents ranged from 13 to 25 per camp with median=19);
- 7 "Engineering" camps (survey respondents ranged from 12 to 25 per camp with median =23);

- 1 "Robotics" camp (survey respondents were 15 girls); and
- 7 "Rocketry" camps (survey respondents ranged from 9 to 28 per camp with median =21).

NASA Theme Activities Students Identified As Their "Favorite"

Camp Name	Number writing a description of their favorite activity	Number of different activities described	Most popular activities
Girls in Science	184	23	<ul style="list-style-type: none"> ➤ Solar oven ➤ Bubbles ➤ Lava lamp ➤ Spectroscope
Solar System	154	22	<ul style="list-style-type: none"> ➤ Solar system ➤ Planets ➤ Rockets ➤ Moon craters
Engineering	135	25	<ul style="list-style-type: none"> ➤ Rockets ➤ Towers ➤ Rover ➤ Chocolate machine
Robotics	15	7	<ul style="list-style-type: none"> ➤ Robot
Rocketry	127	18	<ul style="list-style-type: none"> ➤ Rockets ➤ Marshmallow fight ➤ Hot Chocolate machine

A total of 605 were selected for the random sample evaluation. 95% of those completing the survey provided written answers to the question that asked "What was your favorite activity?" As a group they identified 73 different activities as personal favorites. The answers ranged from naming a broad theme (e.g., "engineering") to describing an action (e.g., "spray painting planets") to activity names (e.g., "Mission 1") to supplies required for the activity (e.g., "cornstarch") to products produced by the activity (e.g., "bridge"). A few of the students (3%) wrote that "all" of the activities were their favorite. Notably popular activities were the solar oven, rockets, and the hot chocolate machine. But the wide array of "favorite activity" is an indicator that the NASA themed activities were engaging and appealing to each and nearly every camper.

Teacher gains in STEM knowledge and confidence to motivate students in STEM (Teacher training participants' (N=140) responses to summer survey)

This week's workshops increased your:	Not at all	A tiny Amount	Moderate amount	To a great extent
<ul style="list-style-type: none"> • STEM content knowledge 	1%	6%	43%	51%
<ul style="list-style-type: none"> • Ability to implement high-quality instructional materials 	0	8%	31%	61%
<ul style="list-style-type: none"> • Capabilities for overcoming the apprehension students feel when faced with abstract math 	3%	14%	42%	41%
<ul style="list-style-type: none"> • Intentions to engage students in using NASA data products and research results 	0	6%	28%	66%
<ul style="list-style-type: none"> • Capabilities for exciting student interest in STEM 	0	5%	24%	71%

More than 75% of the teachers who responded to the survey at the end of training summer 2011 indicated the workshop increased their STEM content knowledge and their capabilities for motivating students in STEM.

Teacher gains in STEM knowledge

(Teacher training participants' (N=22) responses to summer 2012 survey)

How much knowledge did you have about the subject of the NASA summer camp you will lead in 2012:	None	A little	A lot
BEFORE attending the training	24%	71%	5%
AFTER attending the training	0	5%	95%

Nearly all (95%) of the teachers who responded to the survey at the end of training summer 2012 indicated that after attending the training they knew "a lot" about the subject of the NASA summer camp they planned to lead. They also reported that before attending the workshop their knowledge about the subject of the summer camp they would lead was "a little" or "none."

Teacher gains in instructional STEM skills

(Teacher training participants (N=140) responses to summer survey)

Percent of teachers responding to the end-of-training survey (N=140) with survey responses indicating they FELT WELL PREPARED to conduct the following instructional tasks:			
	SoI Training ^a		Nationwide ^b
	BEFORE	AFTER	
Lead a camp (class) of students using investigative strategies	31%	96%	77%
Manage a camp (class) of students engaged in hands-on/project-based work	34%	97%	91%
Help students take responsibility for their own learning	63%	99%	-
Encourage students' interest in STEM	59%	100%	80%
Use strategies that specifically encourage participation of females and minorities in STEM fields	45%	93%	-

- a. SoI Training data source is teachers' responses to items on retrospective-pretest/then-posttest at this project's workshops summer 2012
- b. Nationwide data source is "The Status of Secondary Earth Science Teaching" dated 2002 based on data collected in the 2000 National Survey conducted by Horizon Research for the National Science Foundation

The teachers also indicated gains in instructional STEM skills from before to after attending the training. After the training, more than 95% reported they felt "well prepared" to lead a class of students using investigative activities, manage a camp (class) of students engaged in hands-on/project-based work, and use strategies that specifically encourage participation of females and minorities in STEM fields. Less than half of the teachers reported feeling well prepared in these instructional tasks before attending the training.

Diversity of teachers reached

(Teacher training participants' responses to the summer survey compared to statewide statistics and published data for a nationwide sample)

Percent of Science Teachers			
Background Characteristics	LRGV Sol	Statewide	Nationwide
Female	67%	65%	55%
Male	33%	35%	45%
White	8%	64%	93%
Hispanic	89%	19%	4%
African American	0	8%	2%
Asian or Native American	3%	7%	2%
Years of teaching experience:			
0-10 years	70%	59%	33%
Greater than 10 years	30%	41%	57%
Zero college coursework in:			
Earth/Space Science	29%	-	9%
Life Science/Biology	6%	-	3%
Physics/Physical Science	15%	-	16%
Chemistry	36%	-	17%
Astronomy	66%	-	-
Engineering/Technology	44%	-	-
Math	0	-	-
Degree "Out of Field"	38%	32%	-

As a group, the approximately 150 participants in this project's NASA themed teacher training were less experienced than science teachers statewide, and they were more likely to report having had no college coursework in Earth/Space Science compared to a national sample of science teachers. In common with science teachers elsewhere in the state and in the nation, the majority of the participants in the training were female. But unlike their peers elsewhere, the vast majority of the teachers reached during the first two years of this project were Hispanic. These results are consistent with the project's goal of reaching females and minorities to disseminate mission information and use NASA-themed experiences to excite students about science, technology, engineering, and math (STEM).

Teachers' intentions to use NASA activities and materials provided

(N=140 responding to the survey questions)

Percent who "STRONGLY AGREE" they will use the activities and materials to:	
<ul style="list-style-type: none"> Peak student interest and get them personally involved in learning 	82%
<ul style="list-style-type: none"> Provide students opportunity to make hypotheses, test their own predictions, and draw their own conclusions 	70%
<ul style="list-style-type: none"> Inspire students to communicate with one another and with their families to explain what they have learned and what it means. 	81%

At the end of the training, more than 80% of the teachers expressed intentions to use the NASA themed activities and materials to peak student interest and to inspire students to communicate with one another and with their families to explain what they have learned and what it means.

**Diversity of students reached in the LRGV SoI Summer Camps
(Summer camp participants' responses to the summer survey)**

Numbers of student participants providing responses to the 2012 summer camp surveys					
	Girls in Science	Engineering/ Robotics	Astronomy/ Solar System	Rocketry	TOTAL
Female	189	54	82	44	369
Male	~	93	75	86	257
White	~	~	~	~	28
Hispanic	172	124	129	81	506
African American	~	~	~	~	23
Asian, Native American, Other	~	13	18	20	>51
Grade 4	51	35	44	23	153
Grade 5	84	50	71	27	232
Grade 6	33	41	37	50	161
Grade 7	12	~	~	13	31
Grade 8	11	~	0	11	>22
Grade 9	~	14	~	~	23
Total	> 189	155	160	132	>626

~ Values were suppressed when the exact count is fewer than 10 individuals. When row or column totals would allow calculation of an exact number where the count is less than 10 individuals, the total is expressed ">" rather than exact.

More than 600 participants in LRGV NASA-themed SoI Summer Camps in 2012 responded to the student survey. Approximately 60% were females. More than 80% of the campers indicated they are Hispanic. Approximately 60% were in grades 4 and 5, but the camps also included substantial numbers of students in grade 6 and lesser numbers of students in grades 7, 8 and 9. This set of result is consistent with the project's goal of reaching female and minority middle school students with opportunities to increase their knowledge and become excited about STEM.

**Student gains in STEM knowledge
(Summer camp participants' responses to the surveys (N > 626))**

Theme of the Summer Camp	Content with largest percent of students reporting "lots" of progress	
Girls in Science: Light & Optics	Understand what colors make up white and florescent light	82%
Engineering	How to follow instructions and use checklists in building a rover or robot	72%
Robotics	Communication skills that form the basis for programming a robot	73%
Solar System and Beyond	Names of planets and other minor bodies in the solar system	78%
Rocketry	Characteristics of engineering design process	64%

The proportions of participating students who reported "lots" of progress on one or more elements of their STEM knowledge during their summer camp experience ranged from 64% of students in the Rocketry camps to 82% of those in the Girls in Science Camps that focused on light and optics. More detail about the specific content areas where students perceived they made "lots" of progress is provided in the camp specific survey reports that are attached to this evaluation report.

**Students' intentions to do science learning activities "now that camp is over"
(Summer camp participants' responses to the summer surveys (N > 626))**

Numbers of student participants providing responses to the summer camp surveys					
	Girls in Science (N > 189)	Engineering/ Robotics (N = 155)	Astronomy/ Solar System (N = 160)	Rocketry (N = 132)	TOTAL (N > 626)
Visit the NASA website	99	94	101	58	426
Talk to my family about NASA	128	107	114	78	427
Read a book about space	86	89	70	50	295
Join a science club when I go back to school this fall	75	64	64	48	251
Ask my teachers at school to do more activities like the ones at camp	123	86	95	54	358
Consider doing a science fair project	103	83	75	47	308
Visit a museum, science center, or planetarium	111	95	84	61	351
Watch television shows that have a science, technology, or engineering theme	91	94	91	64	340
Show some of my friends how to do the activities from summer camp	161	107	108	89	465

Showing some of their friends how to do activities from summer camp, talking to their family about NASA, and visiting the NASA website were the science learning activities that students were most likely to indicate they would do "now that camp is over." These activities were indicated by more than two-thirds of the students. Even though it was selected less often as an activity students intend to do now that camp is over, "joining a science club when I go back to school this fall" was on the list of further science learning activities for approximately 40% of the students.

**Students' reports of the summer camp effects on their motivation for STEM
(N > 626 responding to the summer surveys)**

Numbers of student participants providing responses to the 2012 summer camp surveys					
	Girls in Science (N > 189)	Engineering/ Robotics (N = 155)	Astronomy/ Solar System (N = 160)	Rocketry (N = 132)	TOTAL (N > 626)
Excited interest in learning more about space science	190	144	154	117	605
Lots of progress in knowing the different kinds of careers there are in space science	75	106	95	74	350

More than 95% of the students reported the summer camp experience "excited interest in learning more about space science. And more than half indicated they had made lots of progress in knowing the different kinds of careers there are in space science.

**Students' short answers to questions asking their opinion of their summer camp experience
(N > 626 responding to the summer surveys)**

Numbers of student participants providing responses to the 2012 summer camp surveys					
	Girls in Science (N > 189)	Engineering/ Robotics (N = 155)	Astronomy/ Solar System (N = 160)	Rocketry (N = 132)	TOTAL (N > 626)
Enjoyed summer camp	189	152	157	126	625
Would attend more NASA themed camps	185	128	149	108	570

Virtually all of the students who participated in the survey at the close of the LRGV SoI Summer Camps in 2012 reported that they enjoyed the camp, and more than 90% said they would attend more NASA themed camps.

The most frequent themes in the students' written responses to an open-end question asking them "What will you tell your friends about your days at summer camp?" were that it was fun and/or that it was awesome/amazing/exciting/cool. Other themes were about the activities and projects that the students "made" or "did," that their friends should come to camp, and about what they learned at camp. A few students effused that the teachers and/or the summer camp experience was the "best ever." One student summed it up by saying the NASA summer camp was "the perfect way to spend the summer."

**Teachers' short answers to questions asking their opinion of the training
(N=22 responding to the summer survey)**

Numbers of teacher participants providing responses to the summer 2012 survey	
The training prepared me "a lot" for conducting the NASA themed camp	100%
I feel confident I received the appropriate amount of training to prepare me to teach the camp	100%

Teachers' opinions about their experience in the LRGV SoI teacher training were similarly endorsing. The survey at the close of the teacher training in 2012 asked two closed-end questions seeking teacher's opinions. The teachers participating were unanimous in reporting the training prepared them "a lot" for conducting the NASA camp and that they felt confident they had received the appropriate amount of training to prepare them to teach the camp.

Students' narrative answers to questions asking their opinion of their summer camp experience (N > 626 responding to the summer surveys)

Students' responses to the question: "What will you tell your friends about your days at summer camp?"	
Total number writing a narrative answer to the question: 531	
<p>Theme 1: It was fun.</p> <ul style="list-style-type: none"> ➤ "Super fun visitors come for NASA. When I grow up I will be the first in Mars." ➤ "I had a lot of fun doing experiments at science camp." ➤ "Try it with next year with me because you learn more and have fun." ➤ "It was super fun!" <p>Total of students with this opinion:</p>	186
<p>Theme 2: It was awesome/amazing/exciting/cool</p> <ul style="list-style-type: none"> ➤ "It was real cool and awesome. It got me interested in NASA and its technology." ➤ "It was super, duper, duper fun and awesome." ➤ "You should go to science camp NASA. It was awesome!!" ➤ "They should come and be so excited." ➤ "That we made cool stuff and that I learned a lot of stuff, and you can come too." <p>Total of students with this opinion:</p>	153
<p>Theme 3: I will tell them about activities/projects/what we made/what we did.</p> <ul style="list-style-type: none"> ➤ "I will show them the projects I made." ➤ "About our robots and how we got them to work." ➤ "About the cocoa machine and the air gun where you shoot the marshmallow." ➤ "I know how to make a model rocket. Let's build one." <p>Total of students with this opinion:</p>	62
<p>Theme 4: You should come.</p> <ul style="list-style-type: none"> ➤ "I really liked it and next year you should try it." ➤ "I will tell them to join summer camp! for NASA science!" <p>Total of students with this opinion:</p>	35
<p>Theme 5: I learned...</p> <ul style="list-style-type: none"> ➤ "I'll tell them I went to a science camp and learned about astronauts." ➤ "You learn about space science. There are very fun activities and there is no test." ➤ "That I learn more stuff about NASA in this camp." <p>Total of students with this opinion:</p>	23
<p>Theme 6: Best teachers/camp/summer</p> <ul style="list-style-type: none"> ➤ "They should come to have fun with the <u>best</u> teachers of science." ➤ "It was the <u>best</u> summer I had in my life." ➤ "This was the <u>best</u> "funnest" science camp ever!" <p>Total of students with this opinion:</p>	16

NOTE: Each student's answer was assigned only one thematic code. The total number of responses per theme is, therefore, much higher than the simple totals presented in the table because students often included multiple themes in their narrative (e.g., You should go to science camp NASA. It was awesome!!).

**Teachers' narrative answers to questions asking their opinion of the training
(N = total of 162 respondents to surveys)**

Teachers' responses to the question asking what changes they recommend in the training	
Total number writing a narrative answer to the question:	
Theme 1: It was awesome/excellent/exciting/great/wonderful ➤ "The program is excellent and provides awesome activities" ➤ "This is an awesome and inspiring project making me want to sign up for more." ➤ "Excellent. Fantastic workshop! I surely feel empowered to go teach Astronomy!" ➤ "Wonderful experience and I'm more than sure the students are going to love it." ➤ "Can't wait to get started!" ➤ "Excellent presenter and information was relayed just perfect." ➤ "Training was very well run and exciting!" ➤ "Informative and fun!"	83
Theme 2: Need more of this kind of training ➤ "Bring more sessions!" ➤ "I would love to repeat the rocketry course again." ➤ "Would like the same four topics [in the future] so that I can do the other classes." ➤ "Same courses...I want to do engineering again."	18
Theme 3: Need tweaks in logistics: more lead time/supplies ➤ "Not enough supplies given." ➤ "Have the training closer to [my city]." ➤ "Give schools more time to advertise the camps." ➤ "We need more than \$20 to purchase all the materials needed to implement the activities." ➤ "Give us some time to plan the weeklong camp."	16
Theme 4: Reach more districts/students ➤ "More opportunities needed in the Rio Grande Valley for students in science." ➤ "Extend opportunity to other smaller districts." ➤ "The key is to start early in life so that their love for STEM classes is reached at an early age."	5

Surveys at the close of teacher training gave teachers the opportunity to provide narrative feedback and recommendations. The most frequent theme in the narratives was that the training was awesome/excellent/exciting/great/wonderful. The distant but second most frequent theme was that more of the same kind of training is needed. Recommendations for changing or improving the training were suggestions about logistics (e.g., more lead time and more supplies) and about extending the training to reach more districts and more students.

Key Results:

- NASA themes were Girls in Science, Light and Optics, Solar System Exploration, Engineering, Underwater Robotics, Rocketry, and Living in Space.
- More than 80% of the participating teachers and students were Hispanic and approximately 60% were female. Students were in grades 4-9.
- As a group, the approximately 150 teachers surveyed were less experienced than science teachers statewide and more likely to report having had no college coursework in Earth/Space Science or Engineering compared to a national sample of science teachers.

- Teacher surveys indicated gains in STEM knowledge, critical instructional skills for STEM, and confidence in capabilities for exciting students about STEM.
- At the end of the training, more than 80% of the teachers expressed intentions to use the NASA themed activities and materials to peak student interest and to inspire students to communicate with one another and with their families to explain what they have learned and what it means.
- Students who participated in the surveys administered by RGVSA wrote narratives naming more than 70 of the NASA themed hands-on and project-based activities as their personal "favorite."
- Showing some of their friends how to do activities from summer camp, talking to their family about NASA, and visiting the NASA website were the science learning activities that students were most likely to indicate they would do "now that camp is over." These activities were indicated by more than two-thirds of the students.
- Students and teachers alike described their experiences in the LRGV NASA Summer of Innovation program as "fun" and/or "awesome" and/or "excellent" and/or "exciting" and/or "cool." Teachers recommended more of the same kind of training. Students said they would come to more NASA camps in the future and will tell their friends "next year you should try it."

Conclusions and Recommendations

The project achieved its goals for reaching females and minorities to disseminate mission information and use NASA-themed experiences to excite students about STEM. The wide array of "favorite activity" identified by students who participated in the summer camps is an indicator the NASA themed activities were engaging and appealing to each and nearly every camper. The ringing endorsements by the predominantly female and minority participants indicates the project is succeeded in using NASA themes for teacher training along with summer camp activities to increase capabilities and interest in STEM studies and careers. The teachers' and students' expressed intentions for using and sharing what they have learned will contribute to sustainable progress toward increased diversity and equity in the STEM pipeline. Recommendations emerging from this evaluation echo those of the participants: (1) more of this kind of teacher training is needed and (2) more of these kinds of opportunities to learn that science is "fun" is wanted by the students.

The NASA Summer of Innovation grant was for a four-year period, ending in 2014. Current plans are to provide teacher training through the NASA webinars and a partnership with the Texas Education Agency Regional Service Center. The Rio Grande Valley Science Association as approved funds to continue the student summer engagement through the Boys and Girls Clubs. Training will be provided to their staff and funds have been allocated to purchase materials and supplies. Funding for school-based summer programming is still being solicited.

Bibliography

Robelen, E. (April 2011). Awareness Grows of Importance of Learning Science Beyond School. *Education Week: Science Learning Outside the Classroom*, 30 (27), S2-5.

President's Council of Advisors on Science and Technology, 2010.

Friedman, L. & Quinn, J. (February 2006). Science by Stealth: How After-School Programs Can Nurture Young Scientists and Boost the Country's Scientific Literacy. *Education Week*, 25 (24).

President's Council of Advisors on Science and Technology, 2010.

Coper, H. Charlton, K., Valentine, J.C., & Muhlenbruck, L. (2000). Making the Most of Summer School: A Meta-Analytical and Narrative Review. *Monographs of the Society for Research in Child Development*, 65 (1), 1-127.

Afterschool Alliance. (2008b). Summer: A Season When Learning is Essential. *Afterschool Alert* (33).

http://www.nasa.gov/offices/education/programs/national/summer/education_resources/index.html

http://2000survey.horizon-research.com/reports/sec_earthscience/sec_earthscience.pdf

http://www.tea.state.tx.us/index2.aspx?id=5033&menu_id=886&menu_id2=794