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TABLE OF CONTENTS:

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By: MJ Vargas

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ABSTRACT:

Science education reform has prompted scientists, engineers, and politicians alike to act on the growing need for improved educational programs in the STEM fields. Informal science programs that provide an educational experience outside of a traditional classroom and involve students on real-life and hands-on experiments are among these initiatives. It is hypothesized that informal science programs may increase students' interest and performance in science and related subjects. Here we evaluate this by assessing the impacts of one such program, the Junior Scientist Outreach Program (JSOP), a weeklong, free-of-cost camp with fourth and fifth grade students in a predominately Hispanic/Latino community in central New Mexico. A mixed-methods approach - including pre- and post-JSOP surveys, and follow-up case studies that consisted of interviews of students and teachers, and in-classroom observations - was used to measure the degree to which informal science education initiatives benefit elementary students in traditionally underrepresented populations of typically lower socioeconomic status. Survey data suggest that JSOP increased students' interest in pursuing a career in science and related fields. Case study analyses provide insight into the advantages of informal science education and will be used to influence the design of larger studies. Informal science education has been found to be an effective tool for elementary science education. With hands-on experiments that allow children to apply scientific theory learned from textbooks children are apt to feel more free to explore science, a challenging subject that may not intrigue students that lack in proper academic training.

INTRODUCTION:

The majority of science taught in a classroom setting tends to be solitary, abstract, and divorced from real-world experiences, with little or no connection with the actual objects or events represented (Ramsey-Gassert, 1997). Science teaching in elementary classrooms is often reduced to a collection of facts, discussions about assigned readings, and an occasional activity (Kelly, 2000). Considering the variety of learning styles, the overall objective of teaching science should be to create learning environments which allow students to interact physically and intellectually with instructional materials through hands-on experimentation (Hofstein & Rosenfeld, 1996). Science is an ever-changing body of knowledge that provides a means to progress as a society and should be presented as such.

Informal science education is helpful in promoting classroom science education because participants engage with science on their own initiative and not as part of a mandated school curriculum (Quigley, Pongsanon, & Akerson, 2011). Participation reaps several benefits: a better understanding of concepts, topics, processes, and thinking in scientific and technical discipline; increased knowledge about career opportunities in these fields; and increased appreciation and understanding of science and mathematics, and their applications (Sladek, 1998). Informal science education also has larger impacts on communities as it inspires and promotes interactive learning. Ramsey-Gassert (1997) noted, "Out-of-school learning more commonly involves the accomplishment of an intellectual or physical task by a group that is interacting using real elements, which allows learning to take on greater meaning." Science knowledge and therefore, informal science education will continue to be of importance to the general public and to future generations. It is increasingly important for the general American population to be scientifically literate so that the United States can remain economically competitive (Ondracek & Leslie-

Pelecky, 1999). Therefore, if we want a society that is interested and knowledgeable about the need for scientific research, the basic principles of the sciences need to be integrated early in the pre- college curriculum (Schaefer & Farber, 2004).

Evaluation of the effect of informal science education on traditionally underrepresented populations is not something that has been extensively documented. This study was therefore intended to inform this emerging area of study by evaluating the effectiveness and impacts of a particular summer science camp that served as an impetus for informal science education in an impoverished area of Albuquerque, NM. Informal science education, we hope to demonstrate, is important not only for community outreach purposes but also to heighten student success in science and related subjects. Even when science is taught in "a formal education system, [it is] removed from its natural environment (nature), [and is placed in] an artificial environment (a school classroom)" (Zoldosova & Prokop 2006). Whether classroom education in science is available or not, informal science education is necessary.

Informal science education can serve also as an important connection between the scientific community and the general population. This study was important in this area because of the proximity and value of the University of New Mexico (UNM) to the study location. National Science Foundation Director Rita Colwell said, "We cannot expect the task of science and math education to be the sole responsibility of K through 12 teachers while scientists and graduate students live only in their universities and laboratories. There is no group of people who should feel more responsible for science and math education in this nation than our scientists and scientists-to-be" (Ondracek & Leslie-Pelecky 1999). Additionally, Schaefer & Farber (2004) state that the US is facing a problematic decrease in the number of Americans, of any background, entering the science and engineering workforce and according to a National Science

Foundation report (National Science Board Committee, 2004), if action is not taken now to change these trends, we could reach 2020 and find that the ability of the U.S. research and education institutions to regenerate has been damaged and that their preeminence has been lost to other areas of the world.

Informal science education fits in with solving these issues in several ways. Because interest in science needs to be culminated from an early age, it is appropriate and important to engage students at a young age and most beneficial when done since elementary (Kelly, 2000). This study is focused on elementary students from underrepresented communities and seeks to bring more awareness to the importance of elementary science education. Unfortunately, science education has become a lesser priority, or in some cases obsolete, in public schools. Teachers are not given adequate resources to allow students to 'get their hands dirty' during science lessons (Schaefer & Farber, 2004). Informal science education provides the means for them to do so.

JSOP: A model for informal science education

The Junior Scientist Outreach Program (JSOP), established in the summer of 2010, was primarily an initiative to provide informal science education to fourth and fifth grade students in an area of a large southwestern city that has a predominantly Hispanic community (S. Bergin, personal communication). The primary goal of the program was to make science accessible to the public and care for the community that we live in by connecting an impoverished area of the city to the metropolitan area. Bridging this spatial gap may thereby connect an increasing number of traditionally underrepresented people to more jobs in medicine and science (Markowitz, 2004). In the South Valley communities of this large southwestern city, over 90% of middle school students are eligible to receive a free or reduced-rate lunch, more than 30% of students are enrolled in English as a Second Language (ESL) classes, and less than 49% of students graduate from high school (RDA, 2010). Because of these dismal numbers and their larger effects on society, it is important to continue the Junior Scientist Outreach Program in this area and to monitor the results of this intervention.

JSOP seeks to provide informal science education through a sustainability theme with engaging hands-on projects and demonstrations by science professionals at varying levels in their careers: undergraduate, graduate, and Ph.D. Because air pollution, water pollution, soil pollution, global climate change, habitat destruction and species extinction are some of the environmental problems that we currently face (Yocco, 2010), the sustainability theme is used in all JSOP outreach to provide informal science education and motivation to participants in an attempt to inspire them to become more informed on issues related to their environment.

Since 2011, JSOP has grown from an annual weeklong science camp to also include an after school program that happens weekly each fall semester, and other outreach activities such as participation in traditional cultural celebrations in the area. The weeklong, bilingual, and free-of-cost summer camp, which was evaluated in this study, is provided for children of the area that might not otherwise have the chance to attend a summer camp for socioeconomic or spatial reasons. Informal science education programs provide students with experiences that are enjoyable and relevant to their futures (Sladek, 1998). Therefore, this type of outreach may also impact several aspects of young students' academic success.

We hypothesized that the Junior Scientist Outreach Program would increase students' interest and performance in the classroom in science and related subjects. With heightened interest in these subjects students would be more likely to dedicate more time and effort in these areas. Increased performance in this subject area may be an indication of positive thinking toward science, and could lead to more academic success. Additionally, parents' and teachers' perceptions of these children would change to reflect their newfound interest. These children, therefore, would most likely have improved relationships with these important role models in their lives.

We also hypothesized that JSOP would increase student interest in pursuing a career in science. This may be a product of an engaging curriculum that is both enjoyable and motivating. The curriculum of JSOP was designed to promote critical thinking skills by asking children to develop their own questions. Utilizing the sustainability theme, tools for follow-up activities for the students were developed to promote an increased interest in science by making it relevant to the current generation.

METHODS:

Project Description

In order to evaluate this program and justify its continuation over the long term, we assessed its impact on the participants' attitudes toward and interests in science. We first conducted pre- and post-camp surveys on the total population of camp participants. To follow up the quantitative data from surveys, case studies on five fifth grade students who attended JSOP were conducted. All students attended public elementary schools in a large southwestern school district near the site of the summer science camp. These data together have been used to evaluate the effectiveness of the informal science education outreach and possible impacts on students.

Additionally, because teachers are important role models in children's lives, these case studies have taken their feedback into careful consideration. Teachers were interviewed to provide valuable insight into the children's lifestyles, attitudes toward, and interests in school, and more specifically, their interests in science.

Participants and Setting

The 42 total camp attendees were fourth and fifth grade students from a predominantly Hispanic community in a large southwestern city. All participants provided survey data in some manner. Though there was a target number of three students to be involved in follow-up case studies, five of the students, all of whom were entering fifth grade in the Fall semester of 2011, participated in some way. Each case study was designed to involve three in-class observations, one student interview, and one teacher interview, based primarily on their location and secondly on their, their parent's, and their school's interest in participating in the study that was verified via consent and assent forms. Because of school approval discrepancies with two of the three originally contacted participants, a total of five students participated in some manner. Two students provided only interview data, one student provided only in-class observation data, and two students were able to provide both. The teachers of students that were selected for in-class observation participation were asked to participate by being interviewed; two of three agreed to participate.

In an effort to protect all of the study's participants, consent letters were signed by parents and teachers who participated and assent letters were signed by student participants. It was clear in the letters that participants could withdraw from the study at any time and that it was their choice whether or not they wanted to participate. All data collected has been kept confidential and under lock and key. Additionally, case study participants were assigned pseudonyms to protect their identity. Prior to any data collection, IRB Approval was obtained from both the school district to which the participants' schools belong and the University of New Mexico (HRPO Protocol ID: 11-209).

The 23 camp counselors that aided in the execution of the program were either undergraduate students from the Department of Biology at the University of New Mexico, or high school students from a private high school in the surrounding metropolitan area. All camp counselors volunteered their time. The JSOP curriculum followed a sustainability theme and consisted of activities that demonstrated an active link between involvement in science and measurable positive impact of Earth's current conditions (See Appendix I). In addition to hands-on activities guided by camp counselors, various scientists from Sandia National Laboratories gave presentations on topics such as solar energy, geological processes, and college success. The director of JSOP was also the primary researcher for this study. She was present for all camp activities, including pre- and post-camp survey administration.

Data Collection:

All quantitative data collection was done at the local Community Center where JSOP took place on August 1-5, 2011. Qualitative data was obtained at either the school that the children chosen for the case studies attended or another location that was determined by the researcher and the parents/legal guardians of participants. Pre-camp and post-camp surveys from all children that attended JSOP as "campers" were collected to quantitatively assess the impact of the Junior Scientist Outreach Program, a type of informal science education. Pre-camp surveys (Appendix II) were administered during a registration period two and three days before the camp to each child with his/her parent or legal guardian present. It was crucial that the pre-camp survey be administered before the child participated in any camp activities. This was an attempt to avoid any bias that may have been obtained from influence of JSOP volunteers or students' participation in activities. Post-camp surveys (Appendix III) were administered on the last day of camp, Friday, August 5, 2011, before the closing awards ceremony, which served as the last event in JSOP's curriculum. Few parents/legal guardians of the children were present during this time. Each survey contained ten questions: four asked demographic information, five utilized the Likert scale, and one was open-ended. The Likert scale is a preferred method of testing for children (Laerhoven, van der Zaag-Loonon, & Derkx, 2004.) that asked students to agree or disagree with statements about the importance of school and science such as, "School is fun and important," on a scale of 1-5 with 1 being "strongly agree" and 5 being "strongly disagree" (see Appendices II & III). Each survey took each student between 5 and 10 minutes to complete. Additionally, survey administration times were, at most, eight days apart. None of the camp participants declined participation; however, five did not complete the post-camp survey because they were not present for the last day of the program.

The case study approach was then used to add depth to the survey data. Another goal of the case studies was to further address the importance of supplemental informal science education outreach - and how it affects children's behavior and learning in the classroom - following intervention during the Summer of 2011. Observations of three of the five children's behavior during class time were completed three times per child. Every effort was made to not interrupt instruction. It was not made clear to other students which child was being observed. Notes were taken and then later analyzed. Interviews of two of these three students were conducted after school hours so as not to disrupt instructional time. The third student was unable to participate in an interview because calls for parental approval were never returned. Two additional participants were interviewed, but approval for observation was not granted. Interview questions (Appendix IV) were used to investigate three areas of interest: (1) students' current academic life, (2) students' science education, (3) students' experiences while attending JSOP (Gibson & Chase, 2002).

Two of three teachers of case study participants were interviewed for feedback about the student in question. The third teacher was not interviewed because attempts for contact for approval were not returned. Teacher interview questions (Appendix V) were aimed at getting other valid data points on the children's academic situation. Teachers were asked general questions about how well they know the student in that was observed and were also asked to compare these students to others of the same age group. They were asked, however, to not give names of other students or disclose any other identifying information. The goal was to compare the students chosen for the study with groups of their peers using teachers' perceptions of student achievement.

Data Analysis:

For the quantitative data obtained from the surveys, frequencies of responses to the Likert Scale questions (See questions 5-9, Appendices II & III) were compared among pre- and post-camp surveys using chi-squared and Fischer's Exact tests (PROC Freq, SAS, 1992). We also asked whether frequencies of responses from the question of "What do you want to be when you grow up?" (See question 10, Appendices II & III) varied among boys and girls who attended the camp, and among those who regularly attend public and private schools.

Qualitative data, from first-hand notes of the student and teacher interviews and classroom observations, were coded to look for trends, using an emergent design (Glaser & Strauss, 1967). Case studies expanded upon the statistical analyses to include details that quantitative studies cannot. This mixed-methods approach incorporated standard methods of both quantitative (described above) and qualitative research. All data sets including those of student interviews, teacher interviews and in-class observations, were analyzed separately then later triangulated to establish validity and reliability in the results of the study. A trend was considered valid when it was triangulated by a minimum of three of the data sets.

Limitations

Survey times were at most, eight days apart. This was a limitation of the study because this may have not been adequate time for the students to process the experiences that they had in the camp. Significant changes in student attitudes may have happened much later following the camp, after they were allowed sufficient time to process all the information gained from the activities and presentations. The case study approach sought to ameliorate this limitation, but the survey data obtained was subject to it.

One bias in the research was that some of the participants might have been children who might have already had a predisposition to attend a science camp. The effect of the camp may have been underestimated because of this. That is, the children who were most likely to attend the camp and participate in the study might have already had some interest in science. Another possible bias might be that the researcher also served as the JSOP director during the research.

RESULTS:

Quantitative Analysis

Table 1 shows the frequencies of responses to all Likert scale questions from the pre- and post-camp surveys. According to our survey data of demographic information, the average age of all respondents was 10. In the Fall of 2011, 13 of these students entered 4th grade, while 14 entered 5th grade and 12 entered 6th grade. Throughout the JSOP camp, there were 25 male participants and 17 female participants. In the pre-camp survey, only one child responded that he/she had ever participated in a similar program to JSOP (See question 4, Appendix II). In the post-camp survey, all but one child responded that they would recommend informal science education programs to their peers (See question 4, Appendix III).

		Pre-Camp Questions					Post-Camp Questions				
		L1	L2	L3*	L4*	L5*	L1*	L2*	L3*	L4*	L5*
Likert Scale Responses	1 = Strongly Agree	33	16	25	29	36	38	22	29	31	36
	2 = Agree	6	8	12	7	2	0	7	7	6	1
	3 = Neutral	0	10	1	1	0	0	9	1	0	1
	4 = Disagree	0	3	0	0	0	0	0	0	0	0
	5 = Strongly Disagree	0	2	0	0	0	0	0	0	0	0

Table 1: Frequencies of responses to Likert Scale questions in pre-camp and post-camp surveys (See questions 5-9 in Appendices II & III). (* = indicates missing values in this category).

Although there were 42 total participants in JSOP, only 37 participants' survey data could be considered as valid for meeting the following criteria: 1.) Attended all 5 days of JSOP and participated in all activities and 2.) Completed both the pre-camp and post-camp surveys. All Likert scale responses from the pre- and post-camp surveys were compared using Fischer's Exact Tests. Differences in responses to one question that asked students to agree or disagree to the statement of, "I really want to go to college someday" (See question 5, Appendices II & III), were found to be statistically significant (P=0.0228; See Figure 1). In the pre-camp survey, 85% of respondents strongly agreed (Likert response = 1) that this statement was true, while 15% of respondents agreed (Likert response = 2). In the post-camp survey 100% of respondents strongly agreed that this statement was true (Likert response = 1).

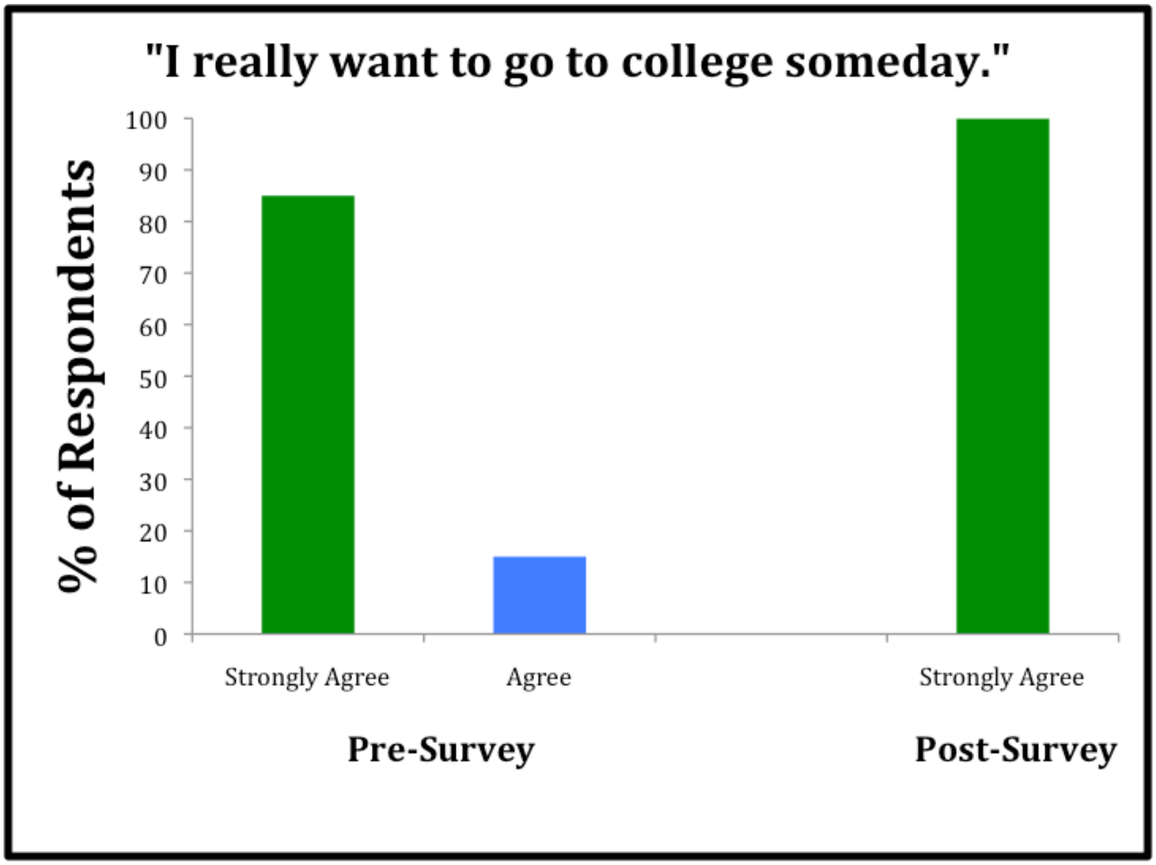

Figure 1: Frequencies of responses differ significantly in Likert question #5 of the pre- & post- camp surveys (See Appendices II & III). (Fischer's Exact Test, df=1, $P<0.05$).

The last question asked in the pre- and post-camp surveys, "What do you want to be when you grow up?" (See Appendices II & III), was analyzed by counting responses and placing them in categories that were generated by the respondents and later condensed by the researchers. These included: Science/Engineering, Doctor, Policeman/Fireman, Nurses/Dental Assistants, Teachers, and "Trendy" Jobs, a category which included careers such as a "superstar" or "professional soccer player". Table 2 below lists the frequencies of responses in each of these categories.

Category	Pre-Camp	Post-Camp
Scientists/Engineers	10.5	14.833
Doctors	5.5	5.33
Policemen/Firemen	7	2
Nurses/Dental Assistants	3	2
Teachers	4	2
"Trendy" Jobs	6	3.5

Table 2: Frequencies of responses within each category of future careers (See question #10, Appendices II &III).

When these frequencies were compared using the graphical representation in Figure 2, a 41% increase in the number of participants wanting to pursue a career in science was observed (corresponds to numerical data in Table 2). All of these students listed their reasoning as being based in the liking for discovery. For example, one fifth grade male respondent said that he, "would like to be a marine biologist," when he grows up because he, "wants to study and discover strange and interesting sea creatures." Another fifth grade female student said she wanted to be a "forensic scientist so that she could to investigate," because she "likes mysteries."

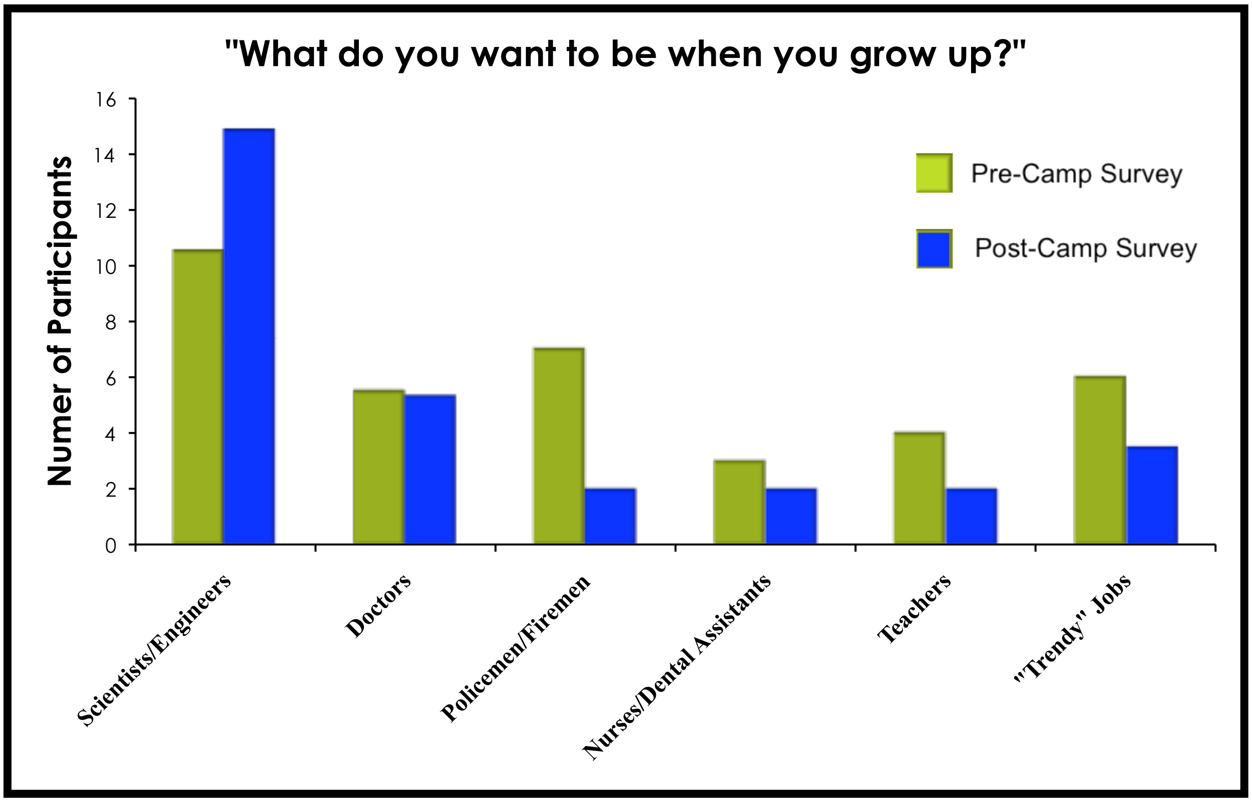

Figure 2: Frequencies of responses to question #10 of the pre- & post- camp surveys (See Appendices II & III).

Other results from the same graph that correlate with this trend are the 71% reduction in number of students wanting to pursue a career as a policeman or fireman and a 41% reduction in the number wanting to pursue "trendy" job that included things such as hairstylists or professional sports players. There was a direct correlation in the reduction of these numbers with the increase in the desire to pursue a career in science. One category that did not seem to fit this trend was that of "Teachers." Upon closer examination, however, the data supports the increase in desire to pursue a career related to science because in the pre-camp survey all of the reasoning listed for those who responded that they'd like to pursue a career in teaching was similar to the example of one fourth grade female: "I would like to be a teacher because school is really fun for me and I would like to show others how school is fun." By the post-camp survey, however, all respondents who listed teaching as their future career choice, listed their reasoning as similar to statements such as, "I just found out how much fun it is to learn science, so I want to show other people how it can be fun too."

To account for the 41% increase in respondents wanting to pursue a career in science, we attempted to identify characteristics that would define the 8 of 37 students whose answers in the pre- and post-camp survey did not match. Six of these eight students changed their answer of career choice from various categories other than a "Scientists/Engineers" in the pre-camp survey to this category in the post-camp survey. Perhaps as a product of our sample size, there were no congruent defining characteristics that were seen throughout, though we looked for similarities such as age, type of school (i.e. public or private), gender and grade level within the group of 8 students.

Additionally, responses to all questions were analyzed for gender differences in change from the pre- and post-camp surveys using Chi-Squared Tests. No statistically significant changes were found (See Table 3). Considering only question #10 from the pre- and post-camp surveys, a trend was found, however, indicating that more males (26%) than females (8%) had measurable increased interest in careers in science (See Table 4).

Chi-Squared Analyses of Gender Differences					
Likert Question	L1	L2	L3	L4	L5
P Value	0.0973	0.248	0.2536	0.5662	0.676

Table 3: Statistical results of gender differences in Likert Scale Questions (See questions 5-9, Appendices II &III).

	Career Choice	Females	Males
Pre-Camp	Scientist	31%	42%
	Other	69%	58%
Post-Camp	Scientist	38%	68%
	Other	62%	32%

Table 4: Frequencies of responses between genders to question #10 of the pre- & post- camp surveys (See Appendices II &III).

Case Studies

Three students were randomly selected from all JSOP participants who completed both the pre- and post-camp surveys, and attended all five days of the program. None of the parents of these original three participants that were chosen responded to phone calls. Three others were then chosen in the same fashion. These three students whom I will refer to as Amber, Isaac, and Molly, all participated in some manner. Amber and Isaac both provided in-class observations and teacher interviews, however, of the two, only Amber provided interview data. Permission for research in the classroom was granted at both Amber's and Isaac's elementary schools, but permission was denied at Molly's school. Although in-class observations and a teacher interview were not possibilities in Molly's case, she and her parents still wanted to provide interview data.

It was necessary to contact another student to fulfill the study's goal of three in-class observations of three JSOP participants. Two other students whom I will refer to as Josh and Marissa, along with their parents, responded to phone calls. Both provided interview data, but only Josh's elementary school granted permission for in-class research. No teacher interview data was available for either of these students. What follows is a case study for each participant that highlights their classroom experience based on whatever data they provided, in any combination.

Case #1: Isaac

Isaac was a fifth grade student at an elementary school in the same neighborhood in which JSOP was held. His legal guardian was his grandmother. As soon as she was contacted to inquire about his participation in the study, she was eager to have him participate. It was likewise relatively easy to receive consent from Isaac's teacher, who I will refer to as Mr. Nelson. Isaac was the first student to be observed for this study and was unable to provide interview data because his guardian did not respond to subsequent requests for an interview with him.

During my first class observation, which was about six weeks after JSOP, I walked in and Isaac was very happy to see me. He jumped up from his seat and ran over to the door to greet me immediately. I was a bit shocked because I had not intended to be such a disruption to the classroom. Mr. Nelson quickly regained control of the class and continued their lesson on phonics. I came to find out later from asking Mr. Nelson after the observation that Isaac was in a special education class. All the children in the class were working with individualized curricula that were what he referred to as "tier three interventions." There were seven students in the class who were all boys. Three of them, including Isaac, were working with the teacher while the four others were working on their own on projects such as reading books or working with flashcards.

In the group of students that was working with Mr. Nelson, each had a notebook and pencil and would take turns answering questions about the pronunciation of suffixes, spelling sounds, and syllables. They moved quickly through the different topics and Mr.

Nelson used a timer to keep track of the length of time they worked on each. While they were working, I noticed that there were clearly listed objectives for specific subjects on the chalkboard. In the math section, for example, the objective read: "Make sure you understand how to round to the nearest 100s place and test out." It seemed that everyone was learning at the same pace for math, but for reading, different objectives were specified by teams. The first team's objective was, "learn and understand the sound 'wa'," while the second team's was, "learn, understand, and use the 'ay' sound." Isaac was in the first team.

There were a couple of behavioral problems from the other students in the class (not Isaac) during this observation and Mr. Nelson addressed them immediately, even though he had to stop teaching for a moment. Isaac and the rest of his classmates would not pay attention to their work, but would instead focus on what was happening during this time. Soon after, another teacher, whom I will refer to as Ms. Garcia, arrived and everyone in the class greeted her. She sat down with the four boys who were working by themselves when I'd arrived. Shortly after they got settled in their lesson that used flash cards, another teacher just walked in and stood to the side to observe. These three interruptions took place within the first 20 minutes of the observation.

The group of students that was working with Mr. Nelson, which included Isaac, was now working on math with workbooks in which they each could write. Again, while they were working, I looked around the room and noticed other surroundings. I saw various posters about geography and cursive then saw that the students had cubbies. There were also various stations set up. One for math, which was a large table next to a chalkboard, and another just like it for reading. All the students with Mr. Nelson were then at the latter. Just then, Isaac said, "I got it, Mr." His teacher replied, "okay, would you like to test out of it?" He said, “yes” and was given a workbook. Mr. Nelson told me that if he answered three or more questions correctly, he would pass that section of the math curriculum and “test out.” During his test, Isaac was very focused and didn’t talk until he let his teacher know that he was done.

Very soon after the timer went off again, the group of students that was working with Ms. Garcia moved to another table and began using multiplication table flash cards. Just then another group of four students, all girls, walked in. All of them had backpacks and sat down at another table and took out workbooks without saying anything. Just as this happened, the phone rang and Mr. Nelson answered it. In between all of this action, Isaac found out that he’d just gotten 100% on his test so Mr. Nelson rewarded him with a few moments of free time to himself. During this time, Isaac just sat quietly for a couple of minutes then walked around the classroom once. The groups then switched again. Isaac remained with the same students, but they were now working with Ms. Garcia using flash cards.

Within the next 20-25 minutes that I was there, two other phone calls were received that Mr. Nelson answered. One of the boys who was in the group of four acted out and was sent to the office, so Mr. Nelson also had to make a phone call to let them know that he was on his way. The switching of activities for the two groups of boys continued throughout this time while the girls remained seated at the same table working quietly on their workbooks. During the time that he did not have to deal with behavioral issues, Mr. Nelson kept on helping kids “test out” of math objectives.

Right before I ended the first observation the timer went off again but this time, Mr. Nelson called for all his students’ “punch cards.” Isaac was first in line. I later found out that they each had two: one for math and one for reading. Everyone got their cards punched and then lined up for lunch. The girls were allowed to go ahead on their own, but the boys were told to line up and follow Ms. Garcia. Isaac was second in this line.

When I arrived for the second observation about three weeks later, neither Mr. Nelson nor any of his students were in his classroom. After waiting a while, I found out that they were in another classroom with a substitute teacher. I finally found them and was told that they were in “collaboration” which was a chance for the students to read and then interact with others. When I arrived in this classroom, I noticed Ms. Garcia, who was present in the first observation. She was sitting and talking with a group of students. I noticed two boys, not including Isaac, sitting off to the side were talking in Spanish. This was the only time I heard this happen. These students continued asking each other questions about spelling and the stories they were reading. Isaac was at this time, sitting in the corner and looking at books with just one other boy.

Just as Mr. Nelson arrived, Isaac and the boy he was reading with began bickering. His teacher saw it and put a stop to it by talking to them outside of the classroom very quickly. After the short disciplinary action, I followed Mr. Nelson and his students back to their classroom, which was only two doors down. He then asked his class for a vote on what they wanted to do until lunchtime. Their choices were either reading or math. The latter won the vote, which is what Isaac had voted for, so Mr. Nelson put on a short educational video called “Math-u-see,” which was about the hundredths place value, for all the 7 boys. Though it took them a little longer than normal to settle down and pay attention, they watched the video and participated when the teacher in the film asked questions. As soon as the video was over they got into one big group and started working on their math workbooks together.

During the time that Mr. Nelson was writing on the chalkboard, Isaac and his classmates were having a tough time paying attention. Mr. Nelson had to recall their attention many times, repeatedly asking for their participation. He also used magnetic blocks that stuck to the chalkboard for the simple math that they were working on. I noticed that Isaac responded quicker to math questions when these visual aids were used.

Even though there was so much effort from Mr. Nelson to structure the classroom and keep the students engaged in the lesson, they were all still very loud and teeming with energy. He asked individuals for participation by having them answer a specific question in the workbook. Just then Ms. Garcia entered the room and sat with the students as they continued working on their math. Mr. Nelson took aside one student at a time and tested them on the lesson they'd just gone over. Although I did not get to see Isaac take his test at this time, I concluded my second visit.

When I walked into Isaac's classroom about two weeks later for my last observation there was relaxing music playing. Four of six boys, including Isaac, were working with Mr. Nelson on reading literacy by learning to pronounce words properly. The other two were looking at flashcards by themselves. Soon after, one other boy, the seventh in the class, walked in and got a pencil out and began working on his own. I noticed that Isaac looked tired or sad. He didn't say much the entire time, even when he was called on for class participation. Even though Isaac was pouting, he still participated more overall as compared to his peers. This was demonstrated by the fact that Isaac raised his hand more and answered more questions aloud than his classmates during this time.

The students that were not directly working with the teacher at this time, not including Isaac, were not focused. Two appeared to be daydreaming and the other was trying to not fall asleep. I think Mr. Nelson noticed this dynamic and told everyone that they could have five minutes of free time before they all started a math video. Isaac came and talked to me during this time and asked about the tree that was planted outside of the community center on the last day of JSOP. He wondered, "Who was watering the tree?" I then explained to him that the community center most likely had a sprinkler system that would make sure that the tree got enough water. His question helped me understand that he did remember the JSOP camp and cared about it in someway.

When the math movie started everyone participated by responding when the teacher in the video asked questions. When it was over the students broke up into groups again and started working on either flashcards by themselves, or on math with Mr. Nelson. Soon after the same four girls as in the first observation entered and sat down at another unoccupied table and started working on their workbooks. The phone also rang two times and Mr. Nelson answered it. It was about the same classroom dynamic for the following 20 minutes until it was time for the students to move around again. It seemed as though they could not wait to do so because they were very restless in their chairs. I did notice that the timer was not used as much during this observation. At this time the students were instructed to put their things away and line up for lunch. We all left the classroom, and with that, my observations of Isaac were complete.

Mr. Nelson agreed to an interview, therefore I went back to the school about two weeks after the last observation during his lunch period. Before I began the standardized questions (see Appendix V), however, I asked him several about his classroom (such as about the use of timers) and the kind of curriculum that the students were being taught. He said, “I don’t like to treat them like special ed. kids.” It was apparent that he cared about the academic progress and wellbeing of the children in his classroom.

When I asked him how well he knows Isaac (question #1) he said that it was Isaac’s first year at that particular elementary school. He said it seemed to him that it was “tough for Isaac to build friendships, but he tries…he really needs work on his social interaction.” It was apparent in the observations, I’d agreed, that his behavioral issues prevent more learning from taking place. In regards to the status of his parental involvement (#2), Mr. Nelson said that Isaac’s grandmother was always very concerned and called him about once or twice per week. He said that it was because of this kind of support that Isaac was able to progress to being in regular education reading.

In response to question #3, Mr. Nelson said that Isaac was “excellent in reading, but gets really frustrated in math.” He said that all of the children in his class, however, “just like the gifted students, care about their grades because goals are set.” In response to the 4th, 5th, and 6th questions, Mr. Nelson said that science was not a subject that was taught in his classroom because his students follow such a rigid curriculum in reading and math (the two subjects that are tested by standardized methods) that there is not much time left for science. He did say that Isaac contributed to the educational process in the classroom by “participating and being a good team player.” As I asked Mr. Nelson to rate Isaac on a scale of 1-10 with 10 being the most excellent (question #7), he gave him a 7. He said, “Isaac still needs improvement…behavioral issues get in the way of his learning.” I agreed with him and discussed some things I’d seen during my observations then asked question #8 which was about informal science education and whether or not he agreed that it was a crucial part in the engagement of students in science. In response he replied, "I think those programs are necessary because in here we only cover the basics. We need to supplement this education and give students repetition of important information throughout the year." Again, I agreed and moved onto the final question. Mr. Nelson said in regards to whether he'd recommend programs like JSOP, "yes! Parental involvement and practice outside of school are so important because kids just do not remember what they've learned after the summer. Year round and summer programs are invaluable to us for these reasons."

Case #2: Amber

Amber was eager to participate in the study. Her grandparents, who are her legal guardians as well, asked that I meet them at their house to go over the consent forms. That initial meeting was separate from the interview that I conducted with Amber at a local restaurant that was close to both her home and school. We were there alone because her parents gave me permission to take her there for dinner and the interview. She was a little shy the entire time, but spoke up when I began to ask her questions pertaining to the study.

In response to question #1 (See Appendix IV), Amber said that her favorite parts about school were science and recess. When I asked if she could be more specific about each, she said hands-on projects were her favorite in science, and playing with her friends was her favorite part about recess. When I moved on to question #2 ("What do you enjoy about learning in a classroom?") it was clear that she didn't fully understand the question, and said, "sometimes I'm excited to be there, sometimes not, but yes." I then asked her what she enjoyed about learning outside of a classroom (#3) and she said, " Yes. I like learning outside of a classroom because it is fun to learn about new things." Again, even though I was unable to communicate the question the way I'd intended to, she acknowledged that learning is something that can take place outside of a classroom.

When I asked what she likes or dislikes about learning science (#4), Amber was unable to give me examples. I said it was okay, and moved on to question #5. In response, she said, "no," JSOP did not change what she thinks about school. What was an interesting contrast to both of these responses, however, was what Amber said to answer question #6: "Yes I used the experiments again with my family because I wanted to show them what I learned in the science camp." I am not sure if this meant that she did the experiment again, or if she just showed her family what she took home from the science camp. In any case, she was engaged during JSOP and I would not be surprised if she was excited to share what she'd learned with her family.

When I asked if she'd ever participated in another program like JSOP (#7), she said, "No but now I'm in a youth leadership program at school." She briefly explained it to me as a program where students are given extra responsibilities and taught about proper leadership. I asked why she liked this program and JSOP and how she could compare the two. She quickly responded, "Both are fun to do." When I asked what she wants to be when she grows up (#8), she said after some hesitation, "I want to be… I want to join the criminal justice or something like that. You know, like a scientist or lawyer or detective or one of those." When I asked why, she said, "because I just watch shows of lots of that kind of stuff and it seems very interesting." I was surprised at how honest her response was because it made it so obvious that her motivation for this goal was directly from the media.

Amber said, "Yes" with certainty when I asked her if she wants to go to college one day (#9). She said it is because she "wants to learn all about the criminology stuff… also because I want to know what it is like to go to college." I encouraged her and let her know that even though it is tons of work, it can also be very fun. After I asked her question #10, Amber said, "Yes, science will be important because I can learn more about science [in case] something happens." I asked, "What do you mean?" and she replied, "Like if my family needs help with science." I interpreted this to mean that she would help her family with her future knowledge if she could, but she could not see the direct link in how science might be important in one way or another in her future. At the time, I explained to her that medicine, doctors, etc, were all science related. In response to the last question, Amber said "yes," she would recommend JSOP or other informal science education programs "because [they are] fun and [one] can learn more about how to do fun activities that involve science."

It was relatively difficult to receive consent for in-class observations of Amber. Once I was able to talk to her teacher, the process became much easier. She gave consent and the observations began almost immediately. When I arrived for my first observation, Amber's teacher whom I will refer to as Ms. Lopez, was leading the children back inside from the playground. I followed them to the classroom as Ms. Lopez had them do "animal walks" on their way there. They walked like penguins, then like giraffes and finally, like snakes. Once we arrived at the classroom, everyone got a drink of water then sat down.

Ms. Lopez spoke very slowly, clearly, and concisely as she asked her students to pick out a chapter book and sit down at their desks, which were in rows. There were two students, not including Amber, at the front of the class who needed to finish a test before they could read their books. She let the class know that as soon as they were all done, they would move on to literacy. While the children were reading I noticed several things around the room. There were lots of decorations and students' artwork, writing/vocabulary posters, lots of math posters, a grading scale, globes, and a calendar that had the students' birthdays displayed. The objectives of the class were also clearly listed on the chalkboard, as was their homework assignment that read, "1.) Read for 20 minutes 2.) Math p 47, 48, and 51 3.) Write one paragraph about someone from the past."

The 19 students that were in the class were all reading different books during this time. Some were further along than others; Amber was about ¾ of the way through with her chapter book but others looked as though they were just beginning. A couple of other students weren't reading at all, and were just looking around the room. During this time, Ms. Lopez linked up the Promethean Board (a digital/interactive projection) to her computer. When the two students were done with their tests, she collected them and asked everyone to put their books away and arrange their desks in groups. I noticed that each group of desks had a tub with arts and crafts supplies. The students quietly did as she asked, then sat down again, this time with their desks in small groups.

The class then began its literacy (reading) lesson, which was about history. Ms. Lopez asked lots of questions to guide the lesson and receive class participation, and then explained that she would read it once through then as a class then they'd go through and answer the questions together. Amber remained quiet the entire time, but just did as she was told. Ms. Lopez began reading the story aloud and most of the children paid attention. She interrupted herself only a couple of times to ask a few students to pick their heads up. As soon as the short story was over, I concluded my first visit.

I went back about three weeks later and when I walked in, Ms. Lopez was not there. Instead, a substitute teacher, who I will refer to as Mr. Martinez, was there proctoring a test. I sat in the back and the room was almost silent. Once everyone was done taking their tests, Mr. Martinez gave them the option of either reading their chapter books or drawing. All but two children chose to draw; the others read their books. Because most chose the latter option, I suppose, Mr. Martinez began talking to them about an illustrator's job and what it entails and why it's important. Perhaps because when I introduced myself to him and let him know that I was there to observe science education, he started engaging the class about our solar system, the earth, and what it takes to sustain life on it. As he did, most continued drawing. This discussion went on for about 20 minutes. During this time all the students including Amber were actively participating in and focused on the discussion. It seems as though deeper thought was provoked in several kids because most began raising their hands to ask questions and were nodding their heads and smiling. Amber, however, was not one who shouted out responses to his questions about the earth, sun, etc.

Soon after, Mr. Martinez began telling a story about acequia systems in the Southwest. He kept the class's attention very well and several students raised their hands to ask questions. Though Amber sat quietly most of the time, she did raise her hand several times when he asked questions later on in the class such as "how many of you want to go to college?" During this time, several students began to pay attention to me as I sat in the back of the classroom. Although Mr. Martinez asked them to carry on as normal, perhaps some students thought that they were being evaluated. Soon after his story ended it was time for me to leave. Ms. Lopez was not with her class this entire time, I came to find out later, because she was busy attending to IEPs (Individualized Education Programs) for some of her students.

For the final in-class observation of Amber, which was about two weeks later, I arrived during the second half of the lunch break. I met up with Ms. Lopez in her classroom and began interviewing her until the class was back from lunch. When they arrived she asked each student to get a chapter book and read quietly for 20 minutes for something she called, Silent Sustain Reading (SSR). She said that this helped the students make their learning more self-guided and individualized. During this time, the classroom remained quiet and we finished the interview. Amber looked like she was intently focused. As I looked at her periodically during this reading time, I noticed her smile a couple of times from the reading she was doing. I interpreted this as a sign that she was truly enjoying herself.

As soon as the 20 minutes for SSR was over, the class was led through a quick lesson using the Promethean Board about using conjunctions to form compound sentences. The participation during this time was not as high as Ms. Lopez would have liked it to be, it seems, but she said that overall the students were doing well and deserved to be rewarded with their favorite multiplication game. The students got really excited and a couple of them, not including Amber, volunteered to sharpen and hand out pencils to everyone. Amber stayed at her desk.

The dynamic of the room quickly changed as everyone got out their multiplication sheets that they were working on. Ms. Lopez explained that each student was working at his or her own pace at this game and once they master one number in multiplication (e.g. all the 5's, 6's, 7's), they would pass to the next level and could add that number to their multiplication artwork piece that was on the wall. She said that most students were stuck at their 6's and 7's, but Amber was working on her 8's. They went through the game once and then had to grade their own papers. Amber passed her test with 100% and made sure to show me. Ms. Lopez reminded them to be honest and to "take responsibility for their learning and their actions." At the end of this game I concluded my last observation.

As previously stated, the interview with Ms. Lopez was held sporadically throughout the last in-class observation. I gave her a list of the questions I'd be asking (see Appendix V) and she came to the back of the classroom and we talked quietly so I could take down her responses. In response to my question of, "How well do you know Amber?" Ms. Lopez replied, "Very well. Sometimes she makes things too personal. She tells me at the beginning and end of every week how it went with her sisters when they go and visit her mother and things like that." I acknowledged her response and asked question #2. She then said, "Her grandma is great! She has a personal interest in Amber's education. It is great because I don't always have that kind of relationship with each parent." This I definitely felt as being true. Amber's grandmother was very concerned about her wellbeing and education each time I spoke to her about JSOP or the in-class observations at school.

In response to question #3, Ms. Lopez said, "she's always engaged in class. She's always really on top of being attentive and paying attention. She is one of my better students." I agreed and then asked question #4. Ms. Lopez said, "The support she gets from home helps her do better in school. I would rate her above average in my class, although her test scores might not reflect that." Question #5 was already partially answered, so I just asked Ms. Lopez to give me an example of how Amber participates in her class. She said, "she raises her hand, volunteers to help others when she's finished early, and is involved in the youth leadership program." I then asked question #6 and her teacher replied, "She contributes to the learning process for the entire classroom." I asked if Amber might inspire other students to participate and she said, "yes, but no. The other students almost get annoyed with her because they almost can't keep up with her. She gravitates toward the other above average students in the class."

When I asked Ms. Lopez to rate Amber in her interest, engagement and success in school (#7) on a scale of 1-10, with 10 being most excellent, she said without hesitation, "10." I then asked what she thought about informal science education by reading question #8 and she replied, "Yes, I agree. Science is a very hands-on subject and students need those hands-on activities in school to engage them in the learning process. Because only writing, reading, and math are tested with standardized tests, students don't typically spend enough time on social studies and science. " I was shocked to learn that. After a few moments I asked Ms. Lopez the last question of whether or not she would recommend informal science education programs like JSOP to her students and/or colleagues. She said, "Yes, absolutely. I think that science is so crucial and needs to be hands-on, but there is not so much funding for it. It is important though because students need to know these concepts for the math word problems that sometimes come up. There is jargon that they don't always know and that interferes with their learning of other subjects." She says that she, but not all teachers, try and bring in science and social studies (history) through literacy.

Case #3: Josh

Josh was a fifth grade student who attended the largest public elementary school in the area. After failing to receive consent from several other students and their parents, Josh and his family were happy for him to participate in the study. For the after-school interview

I met Josh and his mother and father at a popular local café, which served as a neutral location. His parents had several questions about the study and my role with JSOP, and then signed the consent forms. As I asked Josh the 11 interview questions, his father remained quiet the entire time, while his mother often interrupted and offered unsolicited advice. Though I clearly stated that there was no "right" or "wrong" answer it seemed like his mother was eager to help him do as well as possible.

In response to question #1, "what is your favorite part of school?" Josh replied, "everything…I don't hate anything." To narrow it down a bit, I then asked him for his favorite subject to which he responded, "Writing. I like writing in school when I'm given a prompt." It seemed very straightforward so I moved on to question #2. He didn't understand the original question so I rephrased it and asked, "Can you give me examples of what you like about learning in a classroom?" He responded, "Yes. After we take notes, we get to discuss it and it makes me understand it better." It seems he described his favorite and/or the most efficient way for him to learn. In response to this question Josh also said, "My teacher talks with his hands rather than just speaking all of the time. I also like when he uses the Promethean Board (a digital/interactive projection)." It is clear that Josh could clearly articulate the fact that he appreciates visual learning.

In response to question #3, Josh said that the fact that "you get to experience it yourself," is what he enjoys about learning outside of a classroom. For students of any age, it would seem, that experiencing and applying concepts would be more fun than only learning about them in theory. After asking Josh what he likes or dislikes about learning science (#4), he said, "we read and then we get an experiment." From his response it was clear that he didn't fully understand my question. Before I was able to rephrase it, however, his mother asked "Which do you like better?" He then said, "I like them both. The textbook is needed to reinforce the understanding of the experiment." Even though this was not an original study question, it still provided good insight into how Josh perceives science – he needs an external authority to validate it. He was able to state that the understanding of the subject matter is important/relevant to the enjoyment of an activity in science.

When I asked Josh whether JSOP had changed what he thinks about school (#5), he said "No, because this year we're doing 45 minutes of science. Last year we only did 15." He explained that he was then learning about science more than before. In response to question #6, Josh said "yes," because he'd made another baking soda and vinegar volcano at the JSOP after school program he was attending. I was happy to hear this and interpreted his response as the fact that his parents make an effort to expose him to beneficial educational programs. When I asked him about whether or not he'd ever attended a similar program to JSOP (#7), he said, "No." Could it be that science programs are not being held often enough?

After asking Josh what he wants to be when he grows up (#8), he said, "A doctor, but I don't know what type." His mom quickly added, "We've been trying to determine that for years." Both of these responses made it clear that being a doctor was something that he was strongly encouraged to do. When I asked why, he responded without hesitation, "because I want to help people, and that would be fun." It was great to hear such straightforward motives. As I moved on to question #9, Josh responded. "Yes [I want to go to college] because that is a big expectation for doctors." Clearly, this has been a subject he's discussed and thought about many times. He furthered this notion by answering "Yes," to the question (#10) of "Do you think that science will be important to you or your family in the future?" and said this was "because being a doctor will require lots of science. That's important to my whole family." As he said this both of his parents were nodding and smiling. It was so obvious that this was not only what he wanted to do, it was an expectation from his whole family. It was great to see Josh make the connection between science being connected to medicine and therefore, to our future wellbeing.

Before ending the interview, I asked the last question (#11) about whether or not he would recommend JSOP to his friends or other students. In response he plainly said, "Yes." When I asked for an example, he said, "I'd tell them how its fun and that they could make lots of new friends." His mother also added here, "JSOP gives access to new knowledge. That was my favorite part." Even though her input was not explicitly asked for it was appreciated because it lends insight to the impact JSOP has; it is not only limited to students and children, parents and other adults can benefit too.

Consent for in-class observations was readily received from Josh's teacher; he did, however, decline being interviewed. All three observations of Josh were in the afternoon within the last two hours of the school day. When I arrived for the first observation, all the 33 children in Josh's class were in a transition state between activities. All the students were quietly putting away books and getting out craft supplies for thank-you-letters they were about to write for the members of the military currently in Afghanistan. It looked as though each person new exactly what to do. I noticed that during this time the lights were off and the classroom was lit only by natural light. As compared to other schools in the area I'd observed, it was cleaner and the children seemed more engaged. Josh didn't even make eye contact with me the entire time I was there. This was a sign that he'd listened to me as I read the assent forms to him that stated I was not there to interrupt, but rather to observe what a normal class day might look like.

Josh's teacher, who I will refer to as Mr. Davis, was very welcoming. He explained that the last hour of class-time during this day was usually science time, but he had told the class they'd be rewarded with a creative project if they'd done well on their standardized tests, which they did. He offered me a copy of his lesson plans and allowed me to look at some of their slides used on the Promethean Board that Josh had mentioned in his interview. One presentation that I looked at contained a broad range of topics in science, including biology and geology, and overall was much more challenging for a fifth grade class than anything I'd seen during my other observations for this study. There were topics about plant and animal cells and their organelles and functions, the Moh's hardness scale, the rock cycle. Important vocabulary for each topic was enforced in these lessons as well. Though I was unable to see science education in action, it seemed like this group of kids was being challenged to meet their potential in this subject area. Though this was in the presentation and I went to this class repeatedly during science time, I did not ever see it being taught.

To get the class working together after the transition period, Mr. Davis counted down, "5, 4, 3, 2, 1." Everyone responded quickly by quieting down. Mr. Davis asked everyone to take note of the noise level and to please keep it there. For the rest of the time that I was there, they did. I noticed that before beginning his thank-you-letter, Josh looked in his planner for a while. Although this is a good indication for student success, I did not see any of the other students doing this.

As Mr. Davis walked around checking on the students he kept reminding them to "get creative" and told them "there [was] no right or wrong way to do this, and just [asked them] do it to the best of their ability." This conversation continued as he asked out loud, "What does legible mean?" The entire class, including Josh, responded, "that you can read it." After agreeing, Mr. Davis talked a little about the importance of spelling and grammar even in these types of informal letters. With that he left the students alone for a while as he walked to his desk to put some relaxing music on. The classroom remained at this level while the kids were engaged in the letter making for about 30 minutes until it was time for me to leave.

During my next observation that was only two days later, I entered the classroom and again the lights were off. The children were all quietly working on their math workbooks. Everyone except Josh, who had another notebook out as well, had everything else put away. I sat quietly at the side of the room and watched as Mr. Davis walked around helping groups of 3-4 students whose desks were arranged in clusters. I noticed during this time that Josh was talking about the math word problems with his friends in his group. Josh and the two other boys and one other girl were all on topic and displayed teamwork. Mr. Davis quietly let me know that all the students were working on converting fractions to decimals – something I immediately recognized as a tool that is used in science. I don't know if the students have made this connection, however.

As I continued to look around, I noticed that there were fraction charts that the students were using at their desks. It seemed as though this was something the class was working on together, because on the chalkboard there was a prime number tree and underneath was written, "we should all be mastering prime number factorization." During another short side conversation I had with Mr. Davis at this time he said that again this was supposed to be science time, but he was "extending the lesson because [he had] introduced that topic that day because if I'd sent it home for homework, it probably would not have gotten done because the kids nor their parents wouldn't be very familiar with it." It was clear that math took precedence over science because that is the subject that is being evaluated nationwide using standardized tests.

The class continued in this fashion until it was time to put everything away and get ready for school to let out. Mr. Davis assigned homework called, "study links." Josh was the only student during this time that I noticed wrote it down in his planner. Once the classroom was cleaned, Mr. Davis asked aloud, "What is due tomorrow?" All of the students replied, "homework packets!" I saw him write one more thing on the board before I left for the day: "study vocabulary and states and capitals." Still, no science seen in this or any observation.

During my last observation which was exactly a week after the first, I walked in and immediately noticed that Josh was paying close attention to the lesson, which was an interactive play that the children were taking turns reading. Mr. Davis ensured asked each student to make sure they that had a partner, gave me a book so that I could follow along, and then started the lesson over. The children each had a part to read in the play, but there were other parts where they would shout out words or clap together. It was great to see that some children would really emulate the character by changing their tone of voice or pitch to add humor, drama, or excitement to the story. Other kids would laugh and get excited which is a good indication that they were having fun while learning. During the entire time the children were reading, only one had some difficulty reading the words aloud. Josh paid close attention the entire time and was not one of those students who would get jumpy and excited with the story.

The story entitled, "The Catch of the Day," was about a Griot, which was defined in the book as an African storyteller and keeper of the history of the family and the village (Treasures Reading, McGraw Hill). Even though it was not explicitly listed, I inferred that the children were learning about African culture, basket weaving, and storytelling, one form of education. Key vocabulary words were also clearly listed in the margin of the story.

After the story was over, Mr. Davis asked a series of questions about the type of story this is, what morals can be derived from it, and what other information could be deduced. He also pointed out how and why illustrations can help us in our understanding. During this time when he was asking for the class's participation, Josh did not raise his hand to answer questions. When he asked who enjoyed the story, however, everyone including Josh raised his or her hand. Soon after, all the students were asked to put their books away and clean up. There were specific jobs that each one had, and when this time came, they all got to it.

Case #4: Molly

Molly, a fifth grader who attended a school downtown, was a very attentive student at the JSOP science camp. Her mother quickly responded to my request for her daughter's participation in this study. Consent forms were signed at her place of work, while I was there. My attempts at receiving her school's permission were unsuccessful; although her principal gave consent, her teacher did not. I was only able to collect interview data.

One evening I drove about 10 miles out of town to meet Molly and her family at their grandmother's house where her mother said she'd like to have the interview conducted. As soon as I walked in, I was warmly greeted and introduced to her entire family that was there: Molly, her three brothers, two sisters, her mother, two aunts, and her grandmother. We were showed to a room where her mother said we could quietly have the interview. Molly was joyful the entire time.

I went through the 11 student interview questions in sequence. Molly quickly responded to each and was very attentive throughout the duration of our discussion. When asked what her favorite subject in school was, she replied “Math, because its fun.” I asked her if she could provide an example and she said, “well there’s addition, subtraction, multiplication and division, I like them all.” To question #2, she responded, “I enjoy sometimes helping other students and them helping me too.” I now interpret this, as she likes a dynamic environment for learning where she is allowed to interact with others during the learning process.

After I asked the third question I could sense that Molly did not understand what I was asking. I rephrased this to, “Do you think you can learn outside of a classroom?” With enthusiasm she responded, “yes!” “Can you give me an example?” I asked, and she replied, “yeah we can learn about the environment, since we’d be in it, and how to protect it.” I’ve thought about what Molly said here and remember her facial expression. To me, it almost said, “how can we learn about the environment, if we don’t know what its like?” Her favorite things about learning outside, I learned after asking, were “the outside surroundings and trees.” Environmental education, like she was suggesting, is certainly an important facet of informal science education. Topics concerning the environment and sustainability were discussed in length during the JSOP summer camp, so this question was a reflection that our sustainability focus was something with which Molly resonated.

When asked question #4, Molly said that she liked science experiments that she could do on her own. When asked why, she said, “you can make stuff and it can come out really cool.” There was nothing that she could think of that she disliked about science. To question #5, which asked if JSOP changed her thoughts about school, she replied, “no.” The two questions above taken together seem to depict that informal science education outreach may affect the personal interests of children more so than only their perceptions of school.

Molly’s response to question #6 was “no,” because “we haven’t done science even once at school.” I was shocked when she said this. To answer question #7, “have you ever participated in a program similar to JSOP?” Molly responded, “yes, at another community center, but I don’t even remember the name, it had to do with science though.” Science, which was the focus of this other program as well as JSOP, was what she remembered. This seems to be a good indication of informal science education programs that operate for a very short time – though details may not be remembered, the overarching goal of sharing science, is.

When I asked Molly what she wanted to be when she grows up (question #8), she responded, almost before I was done asking, “a doctor!” “What type?” I asked. She replied, “the kind that check your heart and stuff.” For clarification I asked a couple other questions and then determined, and told her, that those types of doctors were referred to as Family Physicians. When I asked why she wanted this career in her future, she responded, “Just because I like helping people.” This shows that she is connecting her goals to good values that have been instilled by those around her. I took the next few minutes to explain how doctors use science to understand the human body and medicine and encouraged her to pursue this goal. After asking Molly if she'd like to go to college one day (#9), she said very simply but firmly, "yes." I followed this question up with #10, "do you think science will be important to you and your family in the future?" She replied, "yes, sometimes when you're a doctor you have to work with science and I want to help my family." I was so impressed that she made the connection so quickly.

To my final question (#11) Molly responded, "yes, I'd tell my friends 'you can learn science for free in this program and then get better grades in school'." Again, I was shocked that she made this connection, especially considering she said that JSOP did not change her view of school.

Case #5: Marissa

Marissa was another student that I was unable to receive permission to observe at her elementary school. I was, however, able to receive permission from her grandmother, who is her guardian, to interview her after school at the same community center where JSOP was held. Both Marissa's grandmother and her younger sister went with her, but gave us space to hold a private interview. During the time that we talked she was very engaged in our conversation, but also seemed nervous as she stuttered quite a bit.

Marissa said that her favorite parts of school were reading, math and science (question #1). When asked the second question, she said that what she enjoys about learning in a classroom is that "[my teacher] doesn't only talk to one student, she talks to everyone to give us all information. She knows lots of things from the book and is always helpful. She never ignores anyone." Here it is clear that Marissa values attention in the learning process, but likes group settings.

When asked the third question, Marissa responded that she enjoys learning outside of a classroom, "because we get to learn in and out." I clarified her response and she agreed that she enjoys a changing environment when learning. This is important for elementary students' attention spans, which in turn translates to more actual learning. Marissa's answer to question #4, "What do you like or dislike about learning science?" was interesting. She said, "My favorite part is learning things that I don't know so I can take them to school and tell my teacher so that hopefully she can help me share them with the others." I took this to mean that Marissa was interested and dedicated to sharing the knowledge she has. She takes the learning process a step further by wanting to teach/share what she's learned so that she may continue to learn more.

To question #5, which asked whether JSOP changed her thoughts about school, Marissa responded, "no because I know when I go to school the things I learn about are not the same." I asked for clarification and she agreed that she could not compare JSOP to school. What both educational settings offer are definitely different. In response to question #6, she said that she has not used any of the science experiments that she learned during the JSOP summer camp because "[she has] worked on science but [was learning] how to use microscopes...not the same thing." True, in the summer program, again, our focus was sustainability; we talked mostly about renewable energy, geology, ecology, and hydrology. I took the time to explain that microscopes in various types of science can be used to better our efforts at sustainability and she agreed. In the following question (#7), Marissa said that she had not ever participated in another program similar to JSOP.

After asking Marissa what she wanted to be when she grows up (#8), she replied, "a psychologist or a dental assistant… or maybe an anesthesiologist if those two don't work out." More of her response to this question blended with the next (#9), as she said, "I want to go to college because when I go to get a job, I don't want to work at a restaurant - I don't want to be there all day long. One day I want to have a family and I want to spend time with them." Marissa cited her family values and reality of hard work in non-professional industries and good reasons to apply herself in school and pursue a profitable career.

When asked if science would be important to her and her family in the future (#10), Marissa responded, "Yes because if people know about science when they're older then they can teach others what it is like to be a scientist." I suspect that this answer stemmed from the fact that she looked up to, and remembered, the two scientists - a female geologist and male solar cell engineer – who presented to the students who attended JSOP. In response the question #11, Marissa said that she would recommend JSOP to her friends because "it would really help them. They might think they want to be a lawyer, but they might change their mind and [become] a scientist after JSOP." This made it clear to me that she thinks that JSOP is an instrument of change.

Summary of Case Studies

Within all of the interviews and in-class observations one trend that was apparent was that science was not a focus in the classroom. There was no science observed even though the researcher's desire to view science education in action was voiced several times. This is largely due to the fact that science is not being tested in elementary schools. Teachers' main focus in the classroom, therefore, is the preparation of their students for these standardized tests that determine scholastic success on a large scale, and in many cases, also dictate funding. The only way that science is woven into the curriculum, from what was learned in correspondence from Amber's teacher as stated above, is when a teacher, such as Ms. Lopez in Case #2, is creative enough to work it into a literacy lesson such as she did with history in the first observation.

An interesting contrast to this, however, is the fact that science was listed as something that will be important to participants' families in every of the five cases just described. This notion lends much credibility to and sheds light on the need for informal science education programs. There are clearly gaps in the educational systems due to the fact that science is not being taught as a subject that is worthy of testing progress in. Informal science education programs such as JSOP can be of benefit in many ways including by supporting its participants by preparing them for in the rigorous science classes at the high school, college, or graduate levels.

Another trend visible in every case above is that informal science education programs are strongly recommended by all participants. All student participants recommended informal science education programs such as JSOP for reasons such as what Molly said above, "I'd tell my friends 'you can learn science for free in this program and then get better grades in school'." All teacher participants listed their reasoning for recommending informal science education programs as similar to what Mr. Nelson said above; "I think [informal science education] programs are necessary because in [class] we only cover the basics. We need to supplement this education and give students repetition of important information throughout the year." Through informal science programs such as JSOP it can be shown to children that learning should be a fun and life long, constant process. By encouraging this type of discovery-based learning, we can help to educate our society and empower those who may be of a lower socioeconomic status or underrepresented population. As observed and documented in various manners in these case studies, these factors are both relevant and important.

DISCUSSION & CONCLUSIONS:

The data obtained via our mixed methods approach supported one of two hypotheses, which stated that JSOP would increase student interest in pursuing a career in science. This was clearly demonstrated in our analyses of the open-ended question that read, “What do you want to be when you grow up?” and asked, “Why?” The 41% increase in the number of student wanting to become scientists or engineers (See figure 2) triangulated with qualitative data obtained through student interviews and in-class observations. Three of four student interviewees (Cases #3,4,5) listed their future career as medical professionals, either as a doctor or psychologist, both of which require extensive training in the sciences. The fourth said she might use science to obtain her career of being a “detective” (Amber, Case #2). The third point for triangulation comes from the second in-class observation of Amber (Case #2). This science discussion led by a substitute teacher was demonstrative of high interest in science of JSOP participant, Amber, and her classmates.

The other hypothesis that stated that JSOP would increase students’ interest and performance in the classroom in science and related subjects was not supported because an area required for testing the validity of this claim was not available. As seen especially well in the in-class observations of Josh (Case #3) no science is being taught in public classrooms. Also as seen in the interview of Ms. Lopez (Case #2), “Science is a very hands-on subject and students need those hands-on activities in school to engage them in the learning process. Because only writing, reading, and math are tested with standardized tests, students don’t typically spend enough time on social studies and science. “ Ms. Lopez, in the same interview, also stated that "science is so crucial and needs to be hands-on, but there is not much funding for it. It is important though, because students need to know these concepts for the math word problems that sometimes come up. There is jargon that they don't always know and that interferes with their learning of other subjects." It's apparent, then, that science is crucial for not only critical thinking skills, but also for the larger understanding and application of subjects such as math. Reading, writing, and literacy are also subjects that proficiency is necessary in for success in science. This supports the notion that science can be interdisciplinary and encompassing of other subjects because it is so diverse and inclusive. Other subjects can also become interdisciplinary by using science as a tool for their application.

Another interesting trend found in nearly all data sets was that the participants' motivation for their career ambitions and/or activities related to school was related to their desire for the general enjoyment of what they'll do. Responses to questions #8 and #9 in interviews of Molly (Case #4) and Melissa (Case #5) and responses to survey question #10 in pre- and post-camp survey respondents support this. Molly said that she wants to become a doctor because she "wants to help people." She told me that this "would be fun." Similarly, Melissa said in response to question #9 of her interview that she wants to go to college "because [she doesn't] want to work at a restaurant when she gets older… [She'd have] to be there all day long and [would instead] want to be with her family." This would be something that she would enjoy. Its also interesting to note that all students would recommend informal science education programs to their friends or family members because they consider it to be fun.

As there is clearly a marked gap in education as seen in the lack of science instruction in public classrooms, making science relevant through sustainability topics in informal science educational outreach can help elementary students succeed. Yocco (2010) states that messages framed by concerns which focus on the individual, will be better received by the general public, leading to a greater likelihood for them to become engaged. If science lesson content is relevant to participants' daily lives, then there is a greater chance that they will apply what they've learned.

Filing educational gaps through supplemental science lessons in informal science education will only make student participants more prepared for future academic courses, standardized tests such as the SAT or ACT which are necessary for entry into college – something that 100% of the participants listed as being something that they strongly agreed that they wanted (See figure 1). This is because science is a not only a subject but a method for which we can learn more about the world around us. For success in science, critical thinking skills, writing skills, math and statistic skills, and communication skills are all necessary. By making the incorporation of all of these enjoyable through informal science education, which supports learning in all environments, we can help children succeed, as it is natural to do better at what is considered enjoyable to do.

The learning environment provided via informal science education, which differs from that of traditional classroom education in many ways including that the focus is not on adhering to guidelines for appropriate grades to be obtained (Ramsey-Gassert, 1997), is one which was observed to focus more on the learning than anything else. Because in the informal environment there is no pressure of a grading system as well as a hands-on and fun approach to applying the theories and concepts of science (rather than merely learning them in an abstract manner), the focus of the participants was very rarely on anything other than the grasping of the knowledge. During the JSOP camp, there were few behavioral issues that the director or staff had to attend to. This strongly contrasts with what was observed in the hyper-controlled environment seen in observations of Isaac (Case #1). Isaac and his classmates all had behavioral issues that were observed to prevent the focus from being on the subject matter of the class. Also stated in the interview with Isaac's teacher, Mr. Nelson, "behavioral issues get in the way of [Isaac's] learning" and "he really needs work on his social interaction." Social interaction is another benefit provided by JSOP's informal environment.

The greater importance of JSOP and other informal science educational programs, then, is primarily focused on the need for accessibility to science education at a young age due to the lack of exposure to this subject area as demonstrated in this study. It is also based in the need to connect marginalized populations to mainstream knowledge and give students from these communities a voice in their desire to pursue professional careers. The sustainability theme that is used to make the science taught relevant to the current generation allows students to develop their own tools for follow-up activities and demonstrates the importance of the material to the student population.

Implications

There are many consequences of not teaching science at the elementary level including the ill preparedness of students progressing from elementary schools to middle and high schools. A well rounded student cannot be born from a fifth grade level in reading and math with a complete lack of knowledge, or comparably low knowledge, of science. The lack of regularly mandated science curricula in elementary schools is not ensuring the future academic success of upcoming middle and high school students that will attend public schools, but is instead leaving them at a disadvantage for these future tasks they must face. In addition, this lack of preparedness will not give them a competitive advantage against students whose families are wealthy enough to pay for private education, or this private education being available by some other manner, which is certainly not the norm. Without science being mandated in public schools and without the help of informal science educational programs, we are constantly marginalizing our future college students and professionals to be only those who can afford the education - not those who also deserve it and have the ability to succeed at an equal or greater rate. This refers to all traditionally underrepresented groups, classes of lower socioeconomic status, and populations who are constantly marginalized due to race, ethnicity, or religion.

One large implication for informal science education is the implementation of such programs into science institutions such as departments of sciences at universities or national laboratories. Figure 3 below shows a schematic of a possible way of envisioning this notion. Moving clockwise from the top, it can be seen that primary research is what is held as most valuable in science and many similar disciplines. Primary research is where scientists and professionals make fundamental contributions through literary publications to add to a building base of knowledge that makes up the collective whole of the discipline. Because each piece of this knowledge is usually so specific that only those in the given sub-field can interpret the jargon and therefore, the primary research, informal science education outreach can be used to simplify those findings and communicate them to not only the scientific community, but also to the general population. In this way, informal science education could serve as Broader Impacts

Criteria (NSF, 2007) for studies funded by the National Science Foundation or other federal agencies.

Because all proposals for research and education projects through the National Science Foundation are evaluated using two criteria: the intellectual merit of the proposed activity and the broader impacts of the activity on society (NSF, 2000). Specifically addressed in these criteria are the creativity and originality of the idea, the development of human resources, and the potential impact on the research and education infrastructure (NSF, 2000). Certainly because JSOP targets underrepresented populations, focuses on sustainability topics, and teaches informal science education through a curriculum that is capable of being altered to reflect new studies' findings, it can a model to follow for Broader Impacts Criteria.

With the larger audience for science that results from informal science education outreach (bottom of figure 3) much more interest in science and related fields could be sparked. If this motivation is large enough within individuals, it may lead them to pursue careers in science or related fields, and in turn, regenerate the cycle by once again contributing to the ever-growing base of knowledge known as primary research that is at the heart of science and serves as the force which drives it forward. Informal science education programs could again be of aid by helping students prepare for rigorous academic trajectories that are typical of the sciences, by helping to fill in the educational gaps in middle and high school students that result from a lack of exposure to science at a young age. Also, because informal science education programs such as JSOP are directed by college students pursuing degrees in science and other science professionals, college and professional success is modeled to participants and can serve as additional motivation.

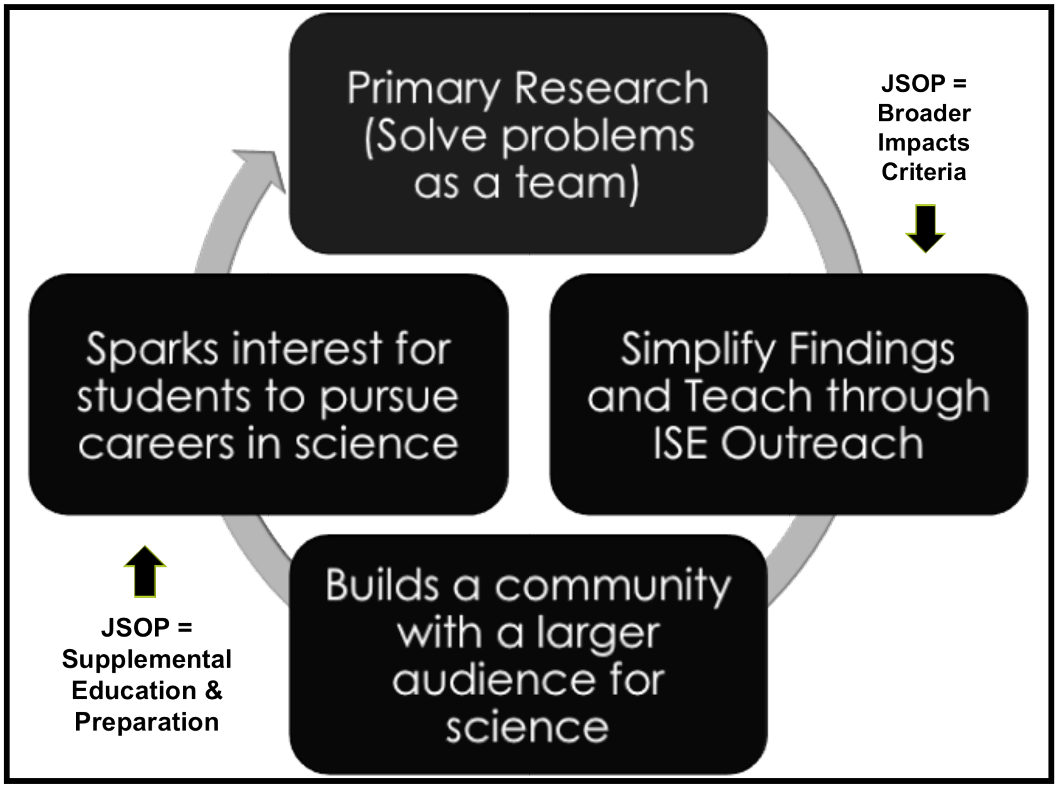

Figure 3: Schematic representation of the broader benefits of integrating informal science education programs into university science departments or other science institutions.

Future Research

Areas for future research on informal science education, and specifically the Junior Scientist Outreach Program, are the questions of: Do informal science education programs, like JSOP, help children improve their grades in school? And how do informal science education programs impact students who receive no science education in elementary school over a long-term period? A control group of students who do not have exposure to informal science education would be necessary to answer these. Also interesting to consider would be the effects of informal science education on teachers, because Kelly (2000) states, "if teachers have never experienced this type of science themselves, it is difficult for them to re-create it accurately in their own classrooms (ibid). This is particularly true of elementary teachers, many of whom have limited proficiencies in science." This may be a question that can be answered with the research model this study has followed.

One last area of study intriguing to consider would be the impact of informal science education on test scores in math and literacy, the two subjects primarily taught and tested in elementary schools. Long term follow-up studies on JSOP, or other informal science education programs, participants would provide insight into the questions of: does continued exposure to informal science education for children in public schools help to fill educational gaps? And, do informal science education programs lead students to pursue careers in science and/or related fields? These studies would require a control group as well.

Informal science education is capable of filling educational gaps from the lack of exposure to the subject in elementary education. Programs such as the Junior Scientist Outreach Program have potential to serve both the scientific and general populations in a number of ways described here. The effectiveness of informal science education with underrepresented populations is a topic that has begun to be explored, however, there are many more questions surrounding this topic that have yet to be examined.

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APPENDICES:

Appendix I: Curriculum for JSOP 2011

Junior Scientist Outreach Program Curriculum 2011					
Day:	Monday	Tuesday	Wednesday	Thursday	Friday
Science Focus:	Geology	Sustainability	Sustainability	Biology/Genetics	Ecology/Hydrology
Main Activities:	Volcano making with baking-soda and vinegar & Earth Crust activity using clay. Presentation by national lab scientist.	Wind Farm simulations & Windmill Engineeting activities. Presentations from university research scholars	Solar oven cookie baking using industrial strength ovens & solar oven assembly from recycled materials. Presentation from national lab scientist.	Strawberry DNA Extractions & Punnet Square gingerbread cookie activity. Presentations from university research scholars.	Tree-planting & closing ceremony. Presentation from local water company with interactive activity on local hydrology.

Appendix II: Pre-Camp Survey

Campers and Parents: We are interested in the extent to which the child enrolling for the Junior Scientist Outreach Program is engaged/interested in science. Please fill out the following few questions to help us provide the best educational experience possible. Responses will be kept confidential.

Name____ **Age**________ **Gender**________

Please circle/fill in the appropriate responses to the following questions.

1. What grade did you complete prior to registering for the camp?

   3rd   4th   5th

2. Please describe the type of school you currently attend.

   Public   Private School   Home School

3. What is your main motivation for participating in the 2011 Junior Scientist Outreach Program?

____

____

4. Have you participated in any other science outreach programs such as the Junior Scientist Outreach Program?

   YES   NO

   If yes, please describe:

Appendix II Pre-Camp Survey Continued:

Please circle the appropriate responses to indicate how strongly you agree or disagree with the following statements.

5. I really want to go to college someday.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

6. I want to have a career in science someday.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

7. School is fun and important.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

8. I want to challenge myself to get good grades in school.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

9. I need to go to school to be successful.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

Please write 1-2 sentences to answer the following questions.

10. What do you want to be when you grow up?

____

____

Why?____

____

____

Appendix III: Post-Camp Survey

Campers and Parents: We are interested in the extent to which the Junior Scientist Outreach Program engaged/interested the enrolled child in science. Please fill out the following questions to help us to continue to provide the best educational experience possible. Responses will be kept confidential.

Name____ Age________ Gender________

Please circle the appropriate responses to the following questions.

1. What grade did you complete prior to registering for the camp?

3^{rd} 4^{th} 5^{th}

2. Please describe the type of school you currently attend.

Public
Private School
Home School

3. Which was your favorite event during the Junior Scientist Outreach Program?

Solar Oven Baking
Lemon Battery Assembly
Presentations from Sandia Labs Scientists
Volcano Making
Strawberry DNA Extractions
Other (Please Describe):

Why?

4. Would you recommend the Junior Scientist Outreach Program to your friends?

YES NO

Why?

Please circle the appropriate responses to indicate how strongly you agree or disagree with the following statements.

5. I really want to go to college someday.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

Appendix III Post-Camp Survey Continued:

6. I want to have a career in science someday.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

7. School is fun and important.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

8. I want to challenge myself to get good grades in school.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

9. I need to go to school to be successful.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

Please write 1-2 sentences to answer the following question.

10. What do you want to be when you grow up?

____

____

Why?____

____

____

Appendix IV: Interview Questions for Students

1. What is your favorite part of school?
2. What do you enjoy learning in a classroom?
3. What do you enjoy learning outside of a classroom?
4. What do you like/dislike about learning science? Why?
5. This summer you attended the Junior Scientist Outreach Program; did it change what you think about school? How?
6. Have you used any of the experiments you learned during the JSOP camp? How? Why?
7. Have you ever participated in another summer camp like the JSOP? If so, what did you like/dislike about the camp compared to the JSOP?
8. What do you want to be when you grow up? Why?
9. Do you want to go to college one day? Why?
10. Do you think science will be important to you or your family in the future? Why?
11. Would you recommend informal science education programs like the JSOP you attended to your friends or other students? Why?

Appendix V: Interview Questions for Teachers

1. How well do you remember the student participating in the study?
2. What do you recall about this student's parental involvement in their education?
3. Was this particular student interested/engaged more or less than other students in science class?
4. Thinking of a science activity or lesson that this student participated in while in your class, how did his/her involvement, interest, and success compare to that of other students in the class?
5. Describe this student's engagement in science activities in school.
6. As compared to his/her peers, how much did this student contribute to the learning experience in any subject?
7. On a scale of 1-10, with 10 being most excellent, how would you rate this student's interest, engagement, and success in school?
8. Informal science education, similar to the Junior Scientist Outreach Program, is said to be a crucial part in engagement of children and young adults in science. Do you agree? Why or why not?
9. Would you recommend informal science education experiences, such as museum visits, summer science programs, etc., to your students and/or colleagues? Why?