INVESTIGATING THE FACTORS THAT MOTIVATE AND ENGAGE NATIVE AMERICAN STUDENTS IN MATH AND SCIENCE ON THE DUCK VALLEY INDIAN RESERVATION FOLLOWING PARTICIPATION IN THE NASA SUMMER OF INNOVATION PROGRAM

A Dissertation

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Authorization to Submit Dissertation

This dissertation of John B. Herrington, submitted for the degree of Doctor of Philosophy and titled "Investigating the Factors that Motivate and Engage Native American Students in Math and Science on the Duck Valley Indian Reservation following participation in the NASA Summer of Innovation Program," has been reviewed in final form. Permission, as indicated by the signatures and dates given below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

In response to the Obama Administration's launch of the "Educate to Innovate" campaign in 2010, the National Aeronautics and Space Administration (NASA) developed the NASA Summer of Innovation (SOI) program, designed to bring NASA educational materials to students and teachers in underserved and underrepresented communities. This study consisted of a mixed methods analysis to determine if the students on the Duck Valley Indian Reservation in southern Idaho experienced a positive change in attitude toward math and science due to their participation in the 2010 NASA SOI, both in the short-term and over a three-year period. Specifically, the quantitative analyses consisted of single-subject visual analysis, a paired-samples *t*-test, and a factorial ANOVA to analyze baseline and follow-up surveys conducted before and immediately after the summer program. Also, a qualitative case study was conducted to determine if the NASA SOI had a lasting impact on the students' positive attitude toward math and science, three years after the completion of the program. The results of the quantitative analyses did not indicate a statistically significant effect of the summer program on the attitudes of the students with respect to science and mathematics over the course of the program (time), between genders, or a combination of both time and gender. However, the narratives derived from the case study indicated the students' attitudes toward science were increased following their participation in the summer program. The qualitative data supported previous research on the importance of family, culture, hands-on experiential and collaborative learning as essential components in Native American students' motivation and engagement with respect to education and science. Additionally, the study found an absence of curriculum that presented historical examples of Native Americans as natural scientists and engineers.

Acknowledgments

I never teach my pupils, I only provide the conditions in which they can learn – Albert Einstein (1879 – 1955)

It has been my privilege to work with outstanding educators at the University of Idaho, who have provided me with the appropriate conditions to learn and excel in my doctoral studies. My sincere appreciation to Dr. Jim Gregson and the members of my committee: Dr. Ed Galindo, Dr. Anne Kern, and Dr. Brant Miller. You have shared with me your passion for education and your desire to improve the educational opportunities for Native American students. Your support, guidance, and encouragement are deeply appreciated. To Bill Anoatubby, Governor of the Chickasaw Nation, thank you for supporting me in my efforts to serve the Native American community. I would also like to thank Dr. Aaron Thomas for leading the NASA Summer of Innovation program across Idaho, Montana, and Utah. Your efforts have brought NASA-themed curriculum to hundreds of deserving students across the Pacific Northwest. To Dr. Tod Shockey, thank you for your assistance in the data collection process and sharing your understanding of SOI program. To Dr. Allen Kitchel, thank you for your invaluable guidance with my research and to Mr. Joe Mirich, the Principal of the Owyhee Combined School. To the students, families, and members of the Duck Valley community, I am deeply indebted to you for making this research possible. It was my honor to interview the students who participated in the NASA Summer of Innovation program. It is my intention to continue a working relationship that brings change to the lives of your students and honors the spirit of your ancestors. To my parents, brother, and sister, thank you for your love and support over the years and for encouraging me to do my very best. To my daughters, I hope my efforts can be an inspiration as you pursue your goals in life. Always believe that you are capable of achieving great things. And most of all, to my amazing wife Margo, without you, I could not have accomplished this work. Your editorial skills know no bounds and your devotion to my educational goal has been unwavering. Thank you from the bottom of my heart. I am so lucky!

Dedication

I dedicate this dissertation to all students who are looking for their path in life. The road may seem long and never-ending, but the journey is an adventure you will never forget and one that no one will ever take from you. Believe in yourself and believe in the people that believe in you.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

> The other day I read a statement to the effect that more than half of the working people in shops and factories in this country today are working in industries that didn't even exist forty years ago. It would seem to mean that, as far as the working population is concerned, half of the old industries have gone into obsolescence and been replaced by new ones. The man who made that statement, a working scientist, pointed out that every worker in every industry today is doing what he is doing either directly or indirectly because of the progress that has been made in the last half century in the physical sciences. In other words, in the material world, in the world of production, of material commodities and material entities, the progress of knowledge, of science, has revolutionized activity (revolutionized is not too strong a word) in the last fifty years. (Dewey, 1938a, p. 96-97)

Though John Dewey wrote those words more than 70 years ago, the content still resonates today. Fast forward to the early 21st century and his argument remains the same. Rapid advances in technology have fundamentally transformed the way the United States' population lives, works, and plays. According to the United States Congress Joint Economic Committee, the improvements in computing, information technology, and biomedicine have produced economic and health benefits that have improved the nation's quality of life and increased the standard of living (United States Congress Joint Economic Committee [USCJEC], 2012). Utilizing and advancing these technologies will require a workforce that has the knowledge and skills to benefit from these technological advances. While the nation as a whole may have shown improvements in these areas, there remain segments of the population that have not realized the benefits of advances in health care and technology (Stanford University, 2013; United States Department of Health and Human Services [USDHHS], 2013). These segments of the population are often regarded as the "underserved community" and represent the portion of the population that receive inadequate services, be it healthcare or technology, and can exist in urban and rural settings (Broadband, 2009; Merriam-Webster, 2013; Moiduddin & Moore, 2008).

For both served and underserved communities, the United States as a whole, lags behind a majority of the world's developed countries in graduating a significant number of qualified scientists and engineers capable of meeting the growing needs of a technologically advanced global economy (Government Accountability Office [GAO], 2013). To address this disparity, the United States educational system must prepare greater number of students at the K-12 level that can successfully enter and complete a post-secondary education in the areas of science, technology, engineering, and mathematics (STEM). The problem lies in how to accomplish such a goal, especially within the underserved and underrepresented populations of the United States (Howard-Brown & Martinez, 2012).

The University of Idaho and the Idaho Space Grant Consortium partnered, under grants from the National Aeronautics and Space Administration (NASA) Summer of Innovation (SOI) program, to conduct one-week summer programs designed to introduce students to NASA-based educational material with the goal of increasing the students' interest in STEM related courses. This study investigated the impact of the Idaho, Montana, and Utah NASA Summer of Innovation (IMU NASA SOI) program had on 17 Native American students from the Shoshone-Paiute tribes who attended school on the Duck Valley Indian Reservation in southern Idaho. More specifically, this study sought to explore the impact the hands-on experiential nature of the IMU NASA SOI program had on the students' attitudes toward STEM. This study evaluated the short-term and long-term impacts of the IMU NASA SOI on this group of students. In addition, this study explored other factors that played a significant role in the motivation and engagement of these students with respect to their education and long-term plans for their futures. The use of a mixed-methods design provided a quantitative and qualitative assessment of the impact of the IMU NASA SOI on the students' attitudes toward science and mathematics as well as identified the importance of family, experiential and collaborative learning in the motivation and engagement of the students with respect to their education and long-term professional goals.

Background of the Problem

The US Bureau of Labor Statistics (BLS) estimated over the next decade, the US labor force will become more ethnically diverse than at any other time in history, where minorities will comprise nearly 40 percent of the civilian labor force (Toossi, 2012). When compared to other developed countries, data from the Organisation for Economic Co-operation and Development ranked the United States 23rd out of 30 countries for employed STEM graduates in the age range from 25-34 years (United States Congress Joint Economic Committee [USCJEC], 2012). The Programme on International Student Assessment indicated test scores for 15-year-olds in math and science ranked 25th and 17th, respectively, out of 34 countries (USCJEC, 2012). At the United States collegiate level, the percentage of bachelor degrees awarded in the STEM fields compared to all bachelor's degrees, decreased from a high of 24% in 1985 to as low as 18% in 2009. Post-graduate degrees fell from a high of 18% down to 14% in the same 14-year period. While bachelor and master degree graduates in STEM have declined, the number of doctoral degrees awarded remained relatively constant, except for the fact that the number of domestic students (American citizens) who graduated with PhDs had fallen markedly from 74% for all STEM PhD's awarded, down to 54%. The 20% decrease in domestic graduates was mirrored by a 20% increase in the number of foreign students graduating with PhDs in the STEM fields (USCJEC, 2012). More often than not, foreign students who earned PhDs tended to return to their home countries and did not fill the STEM vacancies in the United States, exacerbating the critical shortage of scientists and engineers in the United States (USCJEC, 2012). As a result of these findings, the Joint Economic Committee recommended to Congress that this nation must improve access to a quality education in the STEM fields if this nation is to remain competitive in a global economy (USCJEC, 2012).

According to the US Congress, the problem in STEM-related education lies with numerous entities. Lacking a strong foundation in elementary science and mathematics education, students fall behind early in the K-12 educational pipeline (USCJEC, 2012). This is due to a shortage of qualified teachers with hands-on experience in STEM, teachers lacking an educational background in STEM, cutbacks in funding for education, and students not being exposed to mentors or role models in the STEM fields, especially women and minorities (USCJEC, 2012). The inability of the K-12 educational pipeline to produce high school graduates, who are willing to enter college and complete a four-year education in science and engineering, was noted in statistics cited by the National Science Foundation. In 2012, approximately 39.2% of college freshmen chose science and engineering as a major field of study, which included 33% of Native American freshman (National Science Foundation [NSF], 2012a). However, that same year, Native Americans were the least represented minority graduating in science and engineering at 1.8%, with Hispanics at 9.9%, Blacks at 8.4%, Asian and Pacific Islanders at 9.3%, and Whites at 60.2% (NSF, 2012b). Increasing the number of women and minority graduates in science and engineering could help to alleviate the declining number of science and engineering graduates in the United States.

Statement of the Problem

To increase the number of qualified scientists and engineers graduating from post-secondary education, it is imperative that more students become interested in STEM during the formative years of K-12 education, particularly in underserved and underrepresented populations. One of the challenges facing educators today is finding successful methodologies that motivate students to study subjects in the STEM fields. Congress proposed numerous legislative initiatives to address this problem: including the STEM Education Innovation Act of 2011, the STEM Education Coordination Act of 2009, Transforming Undergraduate STEM Education Act, Broadening Participation in STEM Education Act, and the National STEM Education Tax Incentive for Teachers Act of 2011 (Library of Congress [LOC], 2012). Also, numerous innovative summer programs have been introduced across the United States in an attempt to motivate students at the K-12 level to become more interested in the STEM related courses (Ivey & Quam, 2009; LoPresti, Manikas, & Kohlbeck, 2010; Sheridan, Szczepankiewicz, Mekelburg, & Schwabel, 2011; Yilmaz, Ren, Custer, & Coleman, 2010;). Whether or not these programs are successful at making significant changes in student motivation in the long term has yet to be determined, but their success in the short term is encouraging based on the feedback provided by the students and data collected by the program administrators.

In the summer of 2010, NASA instituted the SOI program to enhance the engagement of students in the STEM fields by “strengthening the capacity of community- and school-based organizations that inspire and engage middle school students in STEM content during the summer” (NASA, About the Summer of Innovation section, para. 2, 2012). NASA’s target populations for this program were underserved and underrepresented communities in the STEM fields (women and minorities). The SOI was a collaborative effort between NASA and educational organizations across the United States to develop summer and out of school programs for students that infused NASA educational content in the program activities. In addition, SOI programs included continuing professional development for participating teachers. NASA’s goals for the SOI were two-fold and sought to determine if:

1. Participating students would be more interested in STEM subjects through a better understanding of STEM concepts, eventually leading to a desire to pursue a career in the STEM fields.
2. Participating teachers would be more confident and competent in teaching STEM-related topics.

Another program that exposes students to STEM related material in a short timeframe is Space Camp in Huntsville, Alabama. Space Camp has attracted 500,000 participants in its 30-year history and has, as a primary focus, students in grades four through twelve who participate in weeklong camps that provide hands-on instruction in leadership, teamwork, and decision-making using space or aeronautical themed activities and materials. Student survey data from Space Camp attendees between the years 1987 and 1992 indicated a positive correlation on the camp’s effect at motivating 93% of the respondents to take more science-oriented courses, and 91% to take more math courses (Space Camp, 2012).

Though the goal of the NASA SOI was to motivate students in the K-12 pipeline, adequate longitudinal research has not been conducted to verify whether or not this program was successful. In April of 2010, NASA contracted the services of Abt Associates and the Education Development Center to evaluate the SOI first year pilot project and to provide recommendations for improving the NASA SOI program in the following years. This evaluation was not specifically designed to determine the impact of the NASA SOI on the students; however, the evaluation did review the baseline and follow-up surveys that were administered to the students who participated in the first year pilot program. Unfortunately, the survey was not consistently administered across all of the IMU NASA SOI initiatives due to its length (E. Galindo & T. Shockey, personal communication, September 10, 2013). Only 16% of responses were received from the Idaho Space Grant Consortium, the team that administered the IMU NASA SOI (Rhodes et al., 2011)

Purpose of the Study

This study was designed to evaluate the effects of the 2010 IMU NASA SOI program on the students served on the Duck Valley Indian Reservation on the Idaho-Nevada border. The purpose was to determine whether or not the students demonstrated a more positive attitude toward math and science following the summer program. Specifically, the program was evaluated to determine if the experiential, hands-on nature of the curriculum was a catalyst for students to view STEM courses as an extension of the world in which they find enjoyment, curiosity, and value; thereby motivating them to pursue studies in STEM.

During the summer of 2010, investigators from the University of Idaho conducted one-week summer programs at 13 locations across Idaho, Montana, and Utah under a grant from NASA. These summer programs utilized NASA-themed curriculum to inspire middle school-aged children to study courses in the STEM fields. The population for these summer programs consisted of 5th through 8th grade students from underserved and underrepresented communities in Idaho, Montana, and Utah. The ethnic groups involved were primarily Native American and Hispanic. For the purposes of this study, 17 students from the Duck Valley Indian Reservation who participated in the 2010 summer program were selected as the sample for quantitative and qualitative evaluation.

Theoretical Framework

To ascertain if the students from Duck Valley were motivated by the IMU NASA SOI program, it was essential to understand the theory behind motivation in the classroom and the effectiveness of experiential education and learning. The theoretical framework grounding this study was based upon the historical work of John Dewey and his belief that students could obtain knowledge by drawing from the experiences that have both meaning and relevance in their lives (Dewey, 1938a). Jean Piaget (1970, 2003), Kurt Lewin (1935), David Kolb (1984), and Carl Rogers (1969) have conducted additional work in the area of experiential learning or experiential education. Additionally, Smith and Girod (2003) investigated cases where educators sought to "psychologize" the subject matter, making the content more relevant to their students' lives.

Dewey (1968) argued the aim of education should be to utilize the intrinsic activities and needs of a student, based upon their personal experience in life and the "original instincts and acquired habits" that form the foundation of their existence (p. 108). In addition, Dewey (1938a) surmised a student's participation in an activity aroused their natural curiosity and increased their initiative to pursue that activity. With respect to education and educators, Dewey asserted there was a connection between the experience of the students in the classroom and their environment, both physical and social. Dewey viewed the traditional classroom as based on a static method of rote memorization and presentation of the "end products of inquiry" (Wirth, 1966, p. 61). Ultimately, this method failed to engage the students in the actual process of inquiry, depriving them of the excitement that stemmed from the journey of discovery (Wirth, 1966).

In addition to Dewey's work on experiential learning, an understanding of the nature of motivation and how it played a role in a student's education was essential to the study of the effectiveness of the IUM-SOI program. The works of Aragon (2002), Brophy (2010), Covington (2000a, 2000b), Csikszentmihalyi (1993), Huffman, Sill, and Brokenleg (1986), Korkow (2008), and Rindone (1988), were reviewed to develop an understanding of how Native American students were motivated to learn and identify the cultural components that fostered an environment conducive to their education. Given the IMU NASA SOI was designed to be a participatory, experiential, non-competitive, non-graded event, extrinsic factors were not a part of the motivational equation and it was likely that the students were motivated by intrinsic factors related to feelings of satisfaction and natural curiosity. In addition, the experience of the teachers in this environment may have had a positive effect on the students in their charge.

Research Questions

Quantitative data could provide a statistical representation of the effects of the IMU NASA SOI for the one-week period that the program was administered. However, in order to determine if there were longitudinal effects in the following school years, it was necessary to ask questions that provided a qualitative description of the impact on motivation and engagement beyond a statistical measures. Therefore, this study sought to answer the following questions:

1. To what extent was the IMU NASA SOI weeklong hands-on educational program effective in motivating Duck Valley students to study STEM related courses in high school?
2. To what extent was the hands-on experiential format of the IMU NASA SOI essential in motivating Duck Valley students to engage in STEM activities?
3. To what extent were Duck Valley students more likely to study STEM related subjects after exposure to a short-term hands-on experiential education program focused on space/aviation related material?
4. To what extent did culture play in the motivation and engagement of the Duck Valley students when exposed to NASA themed educational material?
5. To what extent did cooperative learning play a role in increasing the interest of Duck Valley students during the IMU NASA SOI program?

Research Design

To evaluate the long-term effects of summer programs that were designed to be innovative and motivate students to study in the STEM fields, it was necessary to conduct quantitative and qualitative research that was longitudinal by design. Often, summer programs conducted pre and post evaluations that focus only on the participants during the short period they are exposed to innovative curriculum (Yilmaz, Ren, Custer, & Coleman, 2010; LoPresti, Manikas, & Kohlbeck, 2010; Ivey & Quam, 2009; Sheridan, Szczepankiewicz, Mekelburg, & Schwabel, 2011; NASA, 2012). The expectation of the principal investigators was students would carry this motivation into the classroom, resulting in more students choosing STEM curriculum, more advanced placement classes, improved test scores, and improved grade point averages. Unless the study was designed to follow the students for the duration of their secondary education, a causal relationship between the summer program and the students' long-term success in STEM curriculum was anecdotal, at best. Also, even though students may choose courses that were more advanced or related to STEM, many other factors may have played an active role in motivating the students (i.e.; new course offerings, dynamic teachers, peer relationships) that had little to do with the effects of the summer program on their desire to pursue STEM coursework.

Even if quantitative research was conducted longitudinally, corroborating the data as causal to the initial summer camp activities was difficult in that maturation effects may have been a threat to the internal validity of the study due to the length of time between the original program and subsequent analyses (Trochim & Donnelly, 2008). Qualitative research, on the other hand, could provide additional data to expand on the original quantitative data as a multiple measurement that minimized the maturation threat which could occur over time (Trochim & Donnelly, 2008). Obtaining the "story" behind students' desires to continue in STEM-related study and how it was directly related to the events of the summer program was essential to developing a "big picture" view of the effects of the IMU NASA SOI. For this reason, a mixed methods research design was optimal in conducting a longitudinal study to evaluate the effects of a summer program on a student's desire to pursue STEM-related coursework for the remainder of their high school career.

Importance of the Study

Increasing the number of students from underserved and underrepresented communities to study in STEM fields while still in primary and secondary education could increase the number of high school graduates that are capable of pursuing post-secondary education in the areas of STEM. Increasing the number of enrolled undergraduates in the STEM pipeline may result in greater numbers of potential graduates with degrees in STEM. In turn, the communities that these students represent will benefit both socially and economically from a more educated populace (American Indian Higher Education Consortium [AIHEC], 2007). On a more specific level, evaluating the positive effects of using aviation/space-related NASA content, as an experiential education tool, may provide educators with a curriculum toolkit that could be administered to their students throughout the school year, rather than relying on a short-term summer exposure.

Population, Sample, and Generalizability

The population for this study consisted of Native American middle and high school students residing in and around Indian reservations in Idaho, Montana, and Utah. This particular population was chosen due to the limited resources available to the students in terms of access to professionals and technology in the areas of STEM, low socio-economic standards, and distances from major population centers. By choosing this population, it may be possible to create a model curriculum that could be used with students from similar socio-economic backgrounds, provided that the context remains representative to the original study (Lincoln & Guba, 1985; Shenton, 2004; Wise, 2011). The participants in the study were 17 students from the Duck Valley Indian Reservation who attended the 2010 IMU NASA SOI program. The sample was not random, but a convenience sample consisting of students that participated in the 2010 IMU NASA SOI. Using a sample of convenience rather than a random sample presented a major threat to the external validity of this study. I acknowledge the limitations of using this type of sampling procedure for those students who volunteered to be in the program. Due to the absence of random sampling, Campbell (1986) argued proximal similarity could be used as an alternative method for generalization to a theoretical population. Campbell (1986) also posited that the use of proximal similarity should normally be implemented based on "expert intuition" (p. 76). Expert intuition implies that the researcher who wishes to generalize the results of a study conducted using non-random sampling, should be able to recognize the similarity of their population with the non-random sample in terms of people, place, time, and setting (Campbell, 1986; Trochim & Donnelly, 2008).

The Duck Valley Indian Reservation encompasses nearly 290,000 acres on the Idaho-Nevada border on land held in trust by the United States Government. The educational system consists of the Owyhee Combined School (K-12), part of a consolidation with the Elko Nevada School District. The Owyhee Combined School serves students from kindergarten through 12th grade on one campus and consists of 92% Native American and 8% other ethnicities. Ninety-five percent of the student population is eligible for free or reduced lunches (Owyhee Combined School, 2012). Figures 1 and 2 provide data from the State of Nevada Criterion Referenced Test (CRT) for the period from 2004 to 2011, which indicate the proficiency of 8th grade students in the Owyhee Combined School in math and science were well below the proficiency level of students in the Elko school district (Owyhee Combined School, 2012, p. 73 & 111). Given the disparity between students in the Elko School District and the Owyhee Combined School, with respect to math and science proficiency, the importance of this type of study is evidence of the need to pursue research on the effects of motivation and engagement of students on the Duck Valley Indian Reservation.

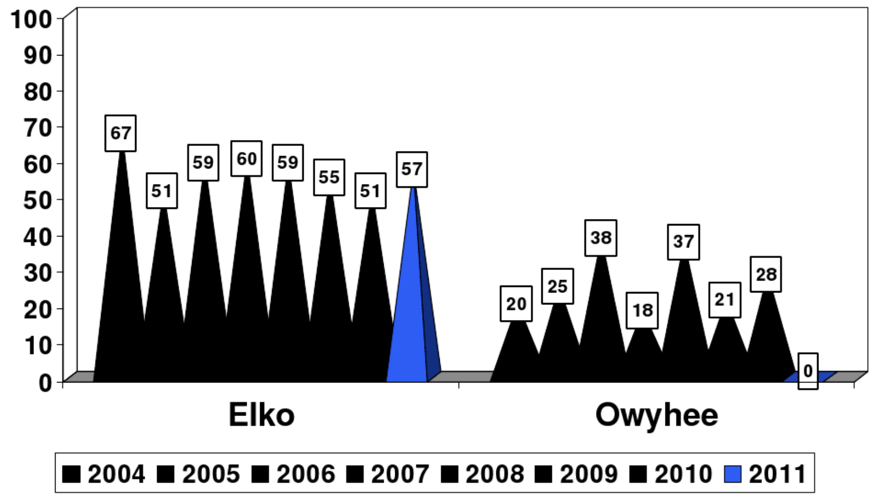

Figure 1. Eighth grade Criterion Reference Tests for mathematics.

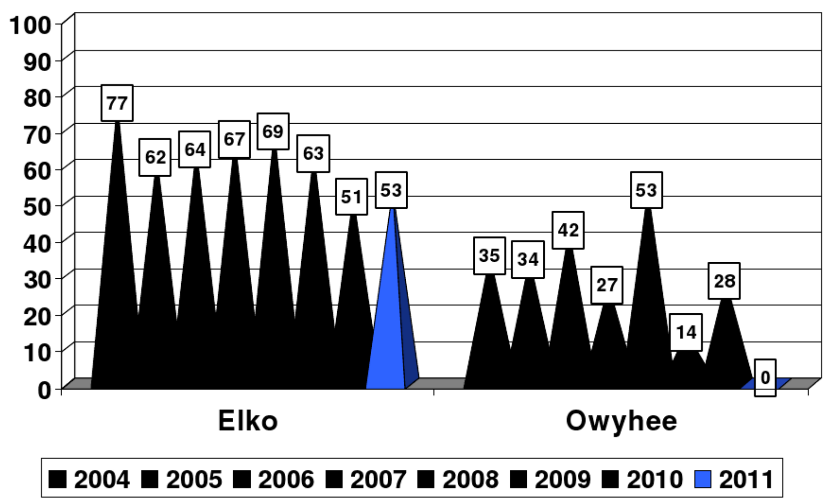

Figure 2. Eighth grade Criterion Reference Tests for science.

Summary

Given that Native Americans are the least represented minority in math and science, there is a need to study their participation in the STEM fields. To meet this need and in response to President Obama's goal of increasing the number of graduates in the STEM fields, NASA developed the SOI program with a focus on underrepresented and underserved communities (The White House, 2012). The implementation of the IMU NASA SOI in the

Duck Valley community was an important component in the NASA strategy to provide NASA-themed materials to motivate and engage Native American students with respect to math and science. It was also imperative that an analysis of the results of the IMU NASA SOI program on this particular population be conducted to determine whether or not the program was successful in achieving the goal of influencing the students' attitudes toward math and science.

Chapter 2: Literature Review

Background

In 2010, the President's Council of Advisors on Science and Technology issued a report to the President of the United States stating, as a Nation, the country must prepare and inspire students who are motivated to study STEM subjects for the United States to respond to the challenges and opportunities the country will face in the future (PCAST, 2010). According to the United States Department of Education, one of the goals for engaging and motivating students to learn was to provide experiences both in and outside of the formal classroom environment to prepare students to be "active, creative, knowledgeable, and ethical participants" in the our global society (United States Department of Education [USDOE], 2010, "Learning: Engage and Empower", para. 1). One of their recommendations on reaching this goal was to "use advances in learning sciences and technology to enhance STEM learning and develop, adopt, and evaluate new methodologies with the potential to inspire and enable all learners to excel in STEM (USDOE, 2010, "Reaching Our Goal", para.1.4).

One institution in the United States considered synonymous with technology and has made inspiration of students one of its overarching strategies is the National Aeronautics and Space Administration (National Aeronautics and Space Administration [NASA], 2012). Through the use of educational materials, based upon NASA's missions and research and through collaborative partnerships with schools and communities, NASA sought to motivate and inspire students to study in the STEM fields. The NASA Summer of Innovation (SOI) was one program that sought to engage students by exposing them to NASA educational materials in a summer camp setting, providing hands-on learning in a collaborative effort between educators and the community (NASA, 2012).

Given that the goal of this research was to determine if the NASA SOI was effective in motivating students, at one particular location in the IMU NASA SOI program, it was important to conduct a literature review that covered three areas pertinent to the target population. First, the majority of the students served by IMU NASA SOI are Native American; a historical overview of Native American education was necessary in order to establish a background on the issues that Native American students face in today's educational climate, which has been influenced by a dominant Western education paradigm (Cajete, 1999). As the principal investigator for this research, I did not want to assume the reader was familiar with the history of Native American education in this country, because the legacy of past injustices are still present in the minds of many in the Native American community and traditional Native American education is not normally understood or recognized by the dominant culture (Cajete, 1999). With respect to STEM education in the Native American community, Bang and Medin (2010) posit that knowledge, learning, and practice of STEM-related information are inherent in Indigenous communities. Bang and Medin (2010) also assert the use of STEM-related information has been, and will continue to be, relevant in their everyday lives.

Second, it was necessary to review databases from the National Center for Educational Statistics and the National Science Foundation in order to quantify the number of students and graduation rates as they were related to Native Americans in post-secondary education, both in general education as well as in the STEM fields. Third, a review of the current body of literature was accomplished, with respect to student motivation, to ascertain theories and methodologies, which have been successful in engaging students in the educational process. In addition, it was important to understand which type of motivation, intrinsic or extrinsic, was effective, particularly in STEM education, with the target population. Lastly, it was important to determine if the current body of literature addressed any cultural differences with respect to motivation in STEM education.

In addition to a review of the literature and the statistics on Native American success in higher education, I believed my personal experience in education and my professional career reflect many of the assumptions and methodologies that research has demonstrated to be effective in motivating students to learn. As such, I included a personal narrative, in the first person (italicized), to substantiate or reinforce concepts that were presented in the literature.

A Brief History of American Indian Education

When conducting research that involves education in the Native American community, it is essential to present an historical overview of the impact of Western culture on American Indian education. The legacy of the boarding school and Western attempts to “civilize” a “savage” culture has had a lasting effect on Native American education (Lomawaima & McCarty, 2006; Reyhner & Eder, 2004). Education was the method used to assimilate Native American youth into the dominant culture (Deloria & Wildcat, 2001; Gere, 2005; Lomawaima & McCarty, 2006; Reyhner & Eder, 2004; Stout, 2012). Some of today’s most prestigious universities have their roots as Indian boarding schools. Harvard, the College of William and Mary, and Dartmouth were all formed under the auspices of bringing education to Native youth (Reyhner & Eder, 2004). While White educators opted for boarding schools for Indian youth, in part because the educators felt that Indian families were a negative influence on the "education" of their own children, Indian parents felt otherwise. Benjamin Franklin wrote of an offer by the government of Virginia to the Indians of the Six Nations of the Iroquois Confederacy to educate their children at a college in Williamsburg, Virginia where funding was established for educating Indian youth in the "Learning of White People" (Franklin, 1784). The response from the Six Nations leadership reflected their belief in their own education system being more beneficial to the needs of their community:

> …that you highly esteem the kind of Learning taught in those Colleges, and that the Maintenance of our young Men while with you, would be very expensive to you. We are convinc'd therefore that you mean to do us Good by your Proposal, and we thank you heartily. But you who are wise must know, that different Nations have different Conceptions of Things, and you will therefore not take it amiss if our Ideas of this kind of Education happen not to be the same with yours. We have had some Experience of it: Several of our young People were formerly brought up at the Colleges of the Northern Provinces; they were instructed in all your Sciences; but when they came back to us they were bad Runners ignorant of every means of living in the Woods, unable to bear either Cold or Hunger, knew neither how to build a Cabin, take a Deer or kill an Enemy, spoke our Language imperfectly, were therefore neither fit for Hunters Warriors, or Counsellors, they were totally good for nothing. We are however not the less oblig'd by your kind Offer tho' we decline accepting it; and to show our grateful Sense of it, if the Gentlemen of Virginia will send us a Dozen of their Sons, we will take great

> Care of their Education, instruct them in all we know, and make Men of them. (Franklin, 1784)

While the needs of the Native community have changed over the past two centuries, the need for education to support and honor their way of life has not. Deloria (2006) viewed the acquisition of knowledge by Indians through observation and inquiry of the natural world, the "aboriginal equivalent of high school and college education" (p. xxx).

In the early-nineteenth century, the Indian Civilization Act was passed which was designed to civilize Indians as well as to make them "persons of good moral character" (Reyhner & Eder, 2004, p. 43). As such, the people chosen by the government to provide a moral education were Christian missionaries (Reyhner & Eder, 2004; Stout, 2012; Trafzer, Keller, & Sisquoc, 2006). By 1824, twenty-one Indian-only boarding and day schools were established, funded by government appropriations and staffed by both Christian missionaries and federal employees. The primary role of these schools was to provide Indian children an education in agriculture in addition to reading, writing and arithmetic (Trafzer, Keller, & Sisquoc, 2006).

In the second-half of the 19th century, responsibility for Indian education was in the hands of the Office of Indian Affairs, the predecessor to the Bureau of Indian Affairs (BIA), and the focus on education began to include more vocational skills; carpentry, blacksmithing, farming for men and domestic work for women (Deyhle & Swisher, 1997; Reyhner & Eder, 2004; Stout, 2012; Trafzer, Keller, & Sisquoc, 2006). Additionally, greater emphasis was placed on developing off-reservation boarding schools designed to remove the Indian child from the influence of their Indian families and prohibit them from speaking their native language (Deyhle & Swisher, 1997; Reyhner & Eder, 2004; Stout, 2012; Trafzer, Keller, &

Sisquoc, 2006). The intent being that immersion in English, eradication of their native language, and removal from their cultural surroundings was the key to assimilation and civilization of Native Americans (Deyhle & Swisher, 1997; Reyhner & Eder, 2004; Stout, 2012; Trafzer, Keller, & Sisquoc, 2006).

In 1874, the first government-run, off-reservation Indian boarding school was established in Carlisle, Pennsylvania. According to its first supervisor, Capt. Richard Henry Pratt, the role of the school was to remove the “Indian” from the Indian (Reyhner & Eder, 2004, p. 143). By 1902, over twenty-five schools were being operated by the Office of Indian Affairs in more than fifteen states (Reyhner & Eder, 2004). The English only requirement that existed in the boarding school approach to Indian education resulted in students having no fluent language to speak at all (Reyhner, 2006). Hence, a “stoic, silent Indian” emerged as a stereotypical myth of the Native American student (Lomawaima & McCarty, 2006, p. 17). Estelle Reel, the Superintendent of Indian Schools under the Office of Indian Affairs from 1898 until 1910, advocated separate courses of study for Indians compared to those of White students (Reyhner & Eder, 2004). Based on her beliefs of “racial inferiority” of Native Americans versus their White counterparts, Reel felt that the course of study for White students, should prepare them to pass entrance exams for college, law school, service academies, or to take positions in bookkeeping, typing, or stenography (Stout, 2012). Her course of study for Indian students did not have the same goal; rather, she prepared them for physical training as a part of America’s laboring class, deeming Native Americans “intellectually inferior” to Europeans and, therefore, should not pursue more intellectually stimulating fields (Lomawaima & McCarty, 2006; Stout, 2012, p. 50).

While boarding schools were the primary vehicles for Indian education at the turn of the 19th century, Native American students began to be assimilated into the public school system. Passage of the Indian Citizenship Act of 1924 and increasing enrollment in the public school system was part of the overall plan for total assimilation of Native Americans into the dominant White society (Reyhner & Eder, 2004). During this time period, one of the findings of the Meriam Report in 1928, a non-governmental investigation into corruption and mismanagement in the Office of Indian Affairs, found that the government administration of the boarding school system was severely deficient (Lomawaima & McCarty, 2006). The report provided a recommendation that was considered radical, that Indians should have the ability to choose their own destiny. Either they could pursue assimilation into the dominant society, or remain attached to their cultural heritage (Lomawaima & McCarty, 2006). Another recommendation of the Meriam Report was to make Native education more "locally relevant," but had the unfortunate goal of reducing academic opportunities for Native students to more vocational areas of study, contrary to the Natives' requests for more accredited academics (Meriam et al., as cited by Lomawaima & McCarty, 2006, p. 71).

Following the Indian Citizenship Act of 1924, Indians gained constitutional and legal protection as citizens of the United States. In addition, the 1934 Indian Reorganization Act was meant to provide more Indian self-governance (Steinman, 2006). In the 1930s, education efforts in the United States became more progressive. Programs that emphasized the child rather than focusing on what was studied, looked more toward active, hands-on learning, rather than passive listening (Dewey, 1968; Reyhner & Eder, 2004). In addition, educational efforts in the Native American community became more bilingual and more schools were established on reservations and under the control of the Bureau of Indian Affairs (Reyhner &

Eder, 2004). In 1934, the Johnson-O'Malley (JOM) Act authorized the federal government to pay states to educate Native American students in the public school system (Reyhner & Eder, 2004).

Following World War II and into the 1960s, minorities challenged the dominant society for greater civil rights. In response, Congressional legislation in the 1960s and early 1970s provided funding in support of Native education (Mavrogordato, 2012; Reyhner & Eder, 2004). During John Kennedy's term as President, there was increased funding and support of BIA schools, and the Johnson administration established the Elementary and Secondary Education Act in 1965, providing more funds for disadvantaged children. The Nixon administration passed the Indian Education Act in 1972, which provided additional funding for Native education both on and off reservations (Mavrogordato, 2012; Reyhner & Eder, 2004; Stout, 2012).

During this timeframe, two major studies were conducted to assess the state of Indian education. Estelle Fuchs and Robert Havighurst (1983) published *To Live on This Earth: American Indian Education*, a summary of the National Study of American Indian Education, conducted between 1967 and 1971. They concluded that Indian education had a history of being a transmission of White American education to the Indian child in a one-way process, with the goal of removing the child from their aboriginal culture and assimilation in the dominant culture. One of their findings indicated that while the parents of most Indian students, as well as many of the students themselves, approved of their schools, they wanted more emphasis on tribal culture (Fuchs & Havighurst, 1983).

In 1969, the Special Subcommittee on Indian Education, chaired by Senator Edward Kennedy, published a summary report, *Indian Education: A National Tragedy - A National*

Challenge. The panel identified alarming statistics with regard to Indian education that included (a) drop-out rates twice the national average; (b) Indian children two to three years behind white students in school achievement; (c) few Indian principals and teachers; (d) teachers not interested in teaching Indian children; (e) and teachers' perceptions that Indian children were "below average" in intelligence (Reyhner & Eder, 2004). The subcommittee recommended the following changes to the Federal Indian School System (Tribal Education Departments National Assembly [TEDNA], 2013):

1. Create innovative programs for the education of disadvantaged children.
2. Develop bilingual and bicultural education programs.
3. Design therapeutic programs to serve the emotional, social, and identity problems of Indian youth.

In response to the Fuchs/Havighurst and Kennedy reports, the Nixon administration passed the Indian Education Act of 1972, which provided more funds for the education of Indian children in the public schools, both on and off the reservations as well as greater funding for culturally relevant curriculum and bilingual education (Lomawaima & McCarty, 2006). In 1975, the federal government passed the Indian Self-Determination and Education Assistance Act, which gave tribes the freedom to contract and operate their own schools as well as other health and social services (Lomawaima & McCarty, 2006). Tribal communities responded by establishing 34 Indian-controlled schools by the end of the decade. Legislation in 1978, the Tribally Controlled College or University Assistance Act, provided additional assistance to tribes for developing their own community colleges, many of which used bilingual and bicultural curriculum (Lomawaima & McCarty, 2006). Today, a total of 34 fully accredited Tribal Colleges and Universities (TCUs) exist nationwide (American Indian College Fund, 2013; USDOE, 2013).

By 2006, tribally controlled colleges and universities (TCUs) had an American Indian and Alaskan Native student enrollment of approximately 13,600 (National Center for Education Statistics [NCES], 2008). Three criteria exist which define a TCU: they must have an enrollment where the majority of students (51%) are American Indian citizens, the majority of TCU board members must be American Indian, and the college must be chartered by the tribe on whose land it resides (American Indian College Fund, 2013). TCUs continue to serve the Native American community and provide culturally relevant and bilingual educational opportunities for Indian students. While all TCUs began as two-year degree granting institutions, by 2007 many offered four-year degree programs and two TCUs granted post-graduate degrees (Chappell, 2007). The original intent for TCUs was to serve the needs of the local tribal community; therefore, many of the courses offered by TCUs were geared toward business, education, or health fields. But as the interests of the students changed over the years and the needs of the communities grew, courses were offered in environmental science, land management, and technology (Chappell, 2007). While TCUs served a large population of the Native American community, total enrollment for Native Americans in public and private two and four-year institutions was approximately 181,000 in 2006; roughly 1% of the total population of college students (NCES, 2008). Enrollment of Native American students in degree granting institutions reached a high in 2009 of approximately 207,900, but has since fallen to 172,900 students in 2012 (NCES, 2013).

Statistics in Native American Education

Given the history of Native American education and the impact on the Indian community for much of the last two centuries, a statistical overview of current Native American education achievement is warranted. In 2008 the Editorial Projects in Education (EPE) Research Center published data profiling the graduation rates in the United States for the class of 2005. The national average for all students graduating from high school was 70.6%. When divided by race and ethnicity, Asian/Pacific Islanders led the class by 81.3% followed by Whites at 77.6%, Hispanics at 57.8%, Blacks at 55.3%, and Native Americans at 50.6% (Edwards, 2008). While Native American students ranked lower than other ethnic group in terms of high school graduation rates in 2005, the number of Native American students that were enrolled in public or private degree-granting institutions more than doubled over the 30-year period from 1976 to 2006 (NCES, 2008). Even so, Native American students still represented only about 1% of total university enrollment in 2006, making them the least represented minority in college enrollment (NCES, 2008; Chen, 2009). Looking specifically at the statistics that address the areas of science, technology, engineering and mathematics (STEM), the National Science Foundation estimates that in 2007, only 0.7% of all bachelor's degrees awarded in science and engineering went to Native American students (National Science Foundation [NFS], 2010). In another study, the figure for Native American students graduating in the STEM fields was even lower at only 0.5% (Babco, 2005). These statistics reinforce the need for more Native American graduates in the STEM fields. With graduation rates so low for Native Americans, research is evaluating whether extrinsic and/or intrinsic motivational factors play a significant role in American Indian education (Reyhner, 2006).

Motivation to Learn

According to the Oxford Dictionary (2010), motivation is "the reason or reasons behind one's actions or behaviour." Maehr and Meyer (1997) view motivation as "personal investment" or the actions a person takes toward a particular activity. The investment that a person dedicates toward a goal is comprised of "direction, intensity, persistence, and quality of behavior" (Maehr & Meyer, 1997, p. 373). Motivation can be further differentiated into the *motives* that propel a student to action, the *goals* that represent the objective of the student, and the *strategies* the student utilizes toward achieving the goal (Brophy, 2010). Covington (2000a) examined the concept of *motives* with respect to achievement by ascertaining whether motives were driven by an "internal need, state, or condition that impels individuals to action" or was motivation the result of actions that are "given meaning, direction, and purpose by the goals that individuals seek out" (p. 173, 174). Was a student motivated by the feeling of satisfaction that comes from achieving success? Did fear of failure prevent some students from attempting a challenging task? Did a student view a monetary reward as a good motivator for working hard to solve a problem or pass a test?

> *I can directly relate to the need for motivation as a prerequisite for studying and succeeding in college level engineering and mathematics courses. My freshman year was dedicated to studying the basics; history, biology, mathematics, and chemistry. My personal interests were directed toward a possible career as a forest ranger because of my love of the outdoors and a desire to not work in an office setting. Granted, I had never met a forest ranger nor had I done any investigation into the employment opportunities or salaries of people working in the field of forestry. My desire*

> *was based purely on a perception of what a forest ranger did, not on actuality. I entered a university in a state where I had just recently moved. I did not know any of my classmates nor did I actively pursue friendships, as I was a shy and introverted individual. I was in an alien environment that I was wholly and inadequately prepared to enter. As a freshman, lacking in direction and motivation to study in a college environment, I focused my attention on outside activities that were engaging, challenging, and rewarding. I found rock-climbing to be the answer to my lack of direction, a pursuit where I could exercise my mind and my body. By exercising my mind, I mean that rock-climbing required one to mentally evaluate the vertical landscape that rises above and develop a plan of action to accomplish the goal of ascending the rock. While I was able to exercise my mind in formulating a solution to my vertical problems, I could not directly translate that mental ability to the classroom. Unfortunately, my studies suffered as a result of my focus on climbing and I performed poorly in two separate subjects and achieved a cumulative grade point average of 1.72. I was subsequently suspended from the university because of poor academic performance. I believe my poor performance was more a reflection of a lack of motivation and not one due to substandard intelligence.*

With respect to student motivation, Brophy (2010) suggested that students seek to engage in activities to achieve a goal. The goal may be a particular learning outcome in a classroom or the student "may pursue other goals in addition or instead" (p. 6). Csikszentmihalyi (1993) described the concept of *flow* with respect to intrinsic motivation where activities were associated with tasks that were both mentally and physically challenging.

> *The sport of rock climbing, both mentally and physically demanding, required a requisite skill set to overcome an obstacle and there was immediate gratification upon completion of the task. Fortunately, my expertise in rock-climbing led to employment as a member of an engineering team tasked with the survey of a potential four-lane highway through the heart of one of Colorado's most spectacular canyons. One of my team's responsibilities was to determine the cross-sectional area of the canyon in order to provide the engineering team with a baseline from which to develop the highway's placement (Haley, 1994). I was required to rappel off the side of the cliffs that lined the highway and then ascend the rope using mechanical climbing devices. On the ascent, I would stop at major projections in the cliff's face and hold a glass prism against the surface of the rock. The prism was used as a reflector for an electronic distance-measuring (EDM) instrument located on a tripod positioned on the centerline of the proposed highway. Aiming the instrument at the prism held against the rock, a surveyor on the ground would command the EDM to emit an infrared beam of light, which was reflected by the prism. The reflected beam of light was received by the EDM, which calculated the distance to the prism based on the time of the light beam's transit and the fact that light travels at a constant velocity. In addition to the distance, the EDM also determined the value of the angle between the horizontal and the line of*

sight to the prism. Using the formula, ***v = d/t***, *where* ***v*** *is the speed of light,* ***d*** *is the distance from the EDM to the prism and back, and* ***t*** *is the time it takes the light to travel the distance from the EDM to the prism and back, one can solve for* ***d*** *by rearranging the equation to read,* ***d = v****t. In order to determine the distance for the EDM to the prism, not the round trip distance, it is necessary to divide* ***d*** *by* ***2***. *Using the basic trigonometric functions and the resulting* ***d/2***, *one can determine the horizontal and vertical distance to the prism. The reality of this type of work and the nature of the calculations conducted by the EDM led me to experience the practicality of mathematics in a real world environment rather than in a textbook.*

Exposure to real mathematical content in an environment outside of the traditional classroom has been shown to be an effective way to motivate students in a summer-camp setting (Chacon &Soto-Johnson, 2003). Also, education outside the classroom is a form of experiential learning, a process where the student acquires knowledge through active participation, (Meyers & Roberts as cited by Teixeira-Poi, Cameron, & Schulman, 2011, p. 245). Cajete (1999) viewed experiential learning as the most basic and holistic form of education and one that has been consistently part of Native American education for centuries. Dewey (1968) posited that a child is more capable of learning in the classroom environment when he or she is engaged in activities that are part of their natural experience. Dewey (1968) argued that as a student matures, natural correlations provide the impetus for gaining knowledge for the sake of discovery.

The practical application of mathematics in an operational setting was only one part of my motivational equation. The other component was an *employee/employer mentor relationship between the owner of the company and me. I was fortunate to have an employer who was willing to provide direction and encouragement to his young and impressionable employee. My employer questioned me regarding my plans for the future and recommended a return to college as the best path to developing a successful and satisfying career. The combination of real world experience and encouragement from a professional was the catalyst for my return to the university with a motivation to learn.*

Perhaps this motivation was parallel to Cleary and Peacock's (1998) discussion of the need for "real purpose" in an academic quest, specifically with respect to Native American students. "When students learn from being involved in projects that had real audiences and real purposes, they understood how to read their world, how to collect information, and how to act on their world" (p. 218). Cleary and Peacock (1997) also recommended that teachers provide students with exposure to possible careers as they seek "self-determination" and devise a plan for their future. While career exploration and projects inside the classroom are beneficial, exposure can also be found outside the school walls and can be more enriching and motivating (Cleary & Peacock, 1997). While Maehr and Midgley (1991) addressed the notion that the "classroom is not an island," in reference to school policies shaping teacher's efforts, their quote can be more literally applied to the outside world as an educational tool (p. 405).

Motivational Theories

Motivation can be differentiated between intrinsic and extrinsic motivation. With extrinsic motivation, the student is motivated by the possibility of receiving an external reward for their actions rather than deriving pleasure from the task alone. Examples of external rewards could consist of grades, classroom recognition, or money. The student may be bored, disinterested, or even dislike the assignment, but the possibility of receiving a good grade, monetary compensation, or recognition in the classroom, may be the motivating factor for a student to see a task to completion (Covington, 2000b). But, external rewards may not be enough. “If someone has to pay me to do this, then it must not be worth doing for its own sake” (Covington, 2000b, p. 23).

Conversely, intrinsic motivation comes from within, an inner desire for action without coercion (Alderman, 2004). Covington (2000a) suggested that intrinsic motivation, or developing a love for learning, might be inhibited if a student also sees an external reward as a consequence of their work. Also, even if a student is intrinsically motivated to study the subject matter, they may still be conscious of their grades and a failure to obtain a desired grade may impact their intrinsic motivation by forcing them to concentrate on performing better while appreciating the subject matter less. On the other hand, achieving a good grade may enhance the student’s intrinsic motivation, satisfying an “internal need” (Covington, 2000a, p. 173).

Brophy (2010) postulated that intrinsic motivation may be the catalyst for students to satisfy a personal curiosity, but may not be something that allows them to dedicate sustained effort to pursue or accomplish specific curricular goals. Some students may view classroom instruction as coercion and not something they choose to pursue freely, out of their own volition or curiosity. Brophy (2010) categorized *student motivation* as the degree to which students were willing to invest attention and effort in the classroom setting, but he argued that teachers should encourage their students to develop a *motivation to learn* by engaging in activities with a desire to acquire knowledge and skills. While it can be difficult to tailor curriculum that meets the motivational needs of all students in the classroom, it behooves a teacher to understand a variety of motivators to address the needs of many students and seek to provide the appropriate measures to sustain students' motivation in the classroom (Eggleton, 1992).

Motivation and Persistence in Native American Education

Numerous studies have been conducted that attempt to identify reasons why Native American students are not prepared for post-secondary education, though few studies have been conducted to investigate the reasons why Native American students have been successful in higher education and have made the choice to study in the STEM fields (Korkow, 2008). Aragon (2002) conducted research to determine what motivated Native American students to learn. His findings indicated Native American students' motivation was maintained through teacher-structured environments, which consisted of feedback, active student roles, and the use of media in the classroom (Aragon, 2002). Aragon (2002) also investigated how Native American cultural values and behaviors conflicted with the academic environment in traditional college settings. Aragon (2002) determined Native American students found competition for grades was an element in higher education to which they were not accustomed; cooperation rather than competition was their cultural norm. From a cultural perspective, was it possible that Native American students relied on the cultural norms that they became accustomed to through interaction in their community? Aragon's (2002) findings suggested the use of active, hands-on experiential learning in a non-competitive environment, that provided positive as well as constructive negative feedback, could be a cultural norm that is successful in motivating Native American students to learn.

While the majority of the studies that were reviewed dealt with persistence and retention in higher education, only one focused on the motivations of minorities pursuing an undergraduate degree in one of the STEM fields (White, 2005). Jeffry White (2005) investigated the factors associated with maintaining an interest in STEM education in order to graduate. His study evaluated the effects of retention programs and activities that were designed to assist students in maintaining an interest in STEM. He found that 95% of those surveyed did not utilize structured assistance programs such as the National Science Foundations Louis Stokes Alliance for Minority Participation. Rather, less structured programs such as peer-study groups or tutoring services led to higher participation rates. White (2005) also observed that students who were active participants in the classroom were more interested in the subject matter. Active participation produced positive emotional responses or positive feelings and the students were more likely to persist in their academic studies (White, 2005).

Many of the mechanisms that encourage and promote retention in post-secondary institutions for Native American students have been identified, but have not necessarily been correlated to why some students choose to pursue study in the fields of science and engineering (Heavyrunner & DeCelles, 2002; Macias, 1989). Is it possible that Native American students studying in the STEM fields use a different set of motivators to maintain an interest in a more academically rigorous environment? If so, these motivators should be identified and translated to students who are in the early stages of deciding which field of study to pursue; in turn, creating a larger number of Native American students in STEM.

Falk and Aitken (1984) stressed that “personal motivation” was necessary for a student to persevere through difficult times. Their study sampled 125 Indian students and 11 college personnel at the University of Minnesota at Duluth. The factors that were identified which contributed most to retention, in order of importance, were; active support of family members, developmental academic preparation, overt institutional commitment, more complete financial aid, and personal motivation (Falk & Aitken, 1984).

Huffman, Sill, and Brokenleg (1986) studied the factors for academic success among a select group of Native American students in South Dakota. The researchers investigated several factors that were related to achievement for Sioux students compared to their White counterparts. For Whites, success tended toward social factors; parental encouragement to attend college and high school GPA, while Native American students relied more on their cultural identity as a source of retention. Huffman, et al. (1986), also found that the college environment was merely an extension of the White students' educational setting that they had grown accustomed to, but was a cultural shift for Native students. Huffman, et al. (1986) suggested conducting a longitudinal study involving a small number of students to determine if their retention of their cultural identity and heritage was instrumental in a strong personal identity and a desire to persist in their academic careers.

Rindone (1988) studied the factors related to achievement motivation and academic achievement among a group of Navajo students who completed a four-year college program. She attempted to identify the "most influential" factors that were related to their success in college. Her desire was to develop a "model that could be used to measure achievement motivation and academic achievement from a Native American perspective" (Rindone, 1988, para. 4). Her findings indicated that a supportive family structure that was stable and based on traditional values was the single most important factor in academic success for the Navajo participants in her study. More specifically, she suggested it was important to determine how family traditional values and family relationships were related to motivating students to study in the STEM fields (Rindone, 1988).

Macias (1989) studied the reasons for academic success among Native American women. She interviewed eleven Native American women enrolled in a graduate program to determine the learning strategies and/or skills they had used in order to be successful in their graduate programs. Her study concluded that strong cultural identity and the skills associated with their culture were essential to their success in college. For example, the ability to synthesize the knowledge they learned in the classroom with their personal experiences on the reservation demonstrated a cognitive ability to critically analyze the subject matter while maintaining a subjective perspective. Also, the women noted that their ability to listen carefully, a culturally valued skill, served them well in the classroom environment. The results of this study support the earlier findings of Huffman, et al. (1986), which indicated that cultural identity and cultural norms played key roles in academic motivation, specifically in the methods the students utilized for learning.

If studies of Native American female college students have shown that a strong cultural identity and the development of skills associated with their culture are key components in their success in college, why don't more Native American females pursue STEM educations? Hill, Corbett, and St. Rose (2010) argued that stereotyping may explain why girls are less likely to pursue careers that demand mathematical ability. However, data from the National Indian Education Study indicated that there was not a measureable difference between Native American boys and girls for mathematical performance in the 8th grade (NCES, 2011). Hill, Corbett, and St. Rose (2010) posited females were more likely to pursue careers that are more impactful from a social perspective. Data from 2006 indicated that 11.9% of first-year American Indian college females intended to pursue studies in the biological and agricultural sciences while only 7.7% of their male counterparts intended to study the same coursework. However, only 2.4% of females chose to pursue degrees in engineering when compared to 14.2% of American Indian males in their first year of college (Hill, Corbett, & St. Rose, 2010). When compared to their White counterparts, more Native American females enrolled in biological and life science curriculum by a margin greater than 3% (Hill, Corbett, & St. Rose, 2010).

When reviewing the literature surrounding motivation in Native American education, it is important to understand that the conclusions reached in these studies may not generalize across the totality of Indian Country. With over 564 Federally recognized tribal entities in the United States, speaking nearly 200 different languages, it would be inappropriate to assume that these findings generalize across such a culturally varied group of people (BIA, 2010; Pewewardy, 2002).

Cultural Border Crossing in Science Education

Given that culture has been found to have a significant impact on the motivation of Native American students in an educational setting, it was important to understand how to best present STEM curriculum to help students cross the “cultural border” between the Western paradigm of science education and their own culture (Aikenhead, 2001, 2006; Cajete, 1999). Aikenhead (2001) posited that Western science education was a “cultural entity itself” and that students must cross a cultural border when moving from the culture of their everyday lives into the world of Western science education (p. 339). For Native American students, they may be hesitant to cross the cultural border because it can be viewed as part of the assimilation process that has plagued Indigenous communities across North

America (Aikenhead, 2006; Reyhner & Eder, 2004; Ward, 2005). Aikenhead (2006) suggested students be guided across this border by teachers who acted as their "culture brokers" (p. 121). The role of the teacher as a culture broker in science education was to acknowledge the border existed, used language from both sides of the cultural border (Native and Western science), and helped students rectify any conflicts that arose between the two cultures (Aikenhead, 2006). The challenge for students was when the teacher did not recognize a cultural border existed and the students attempted the crossing on their own (Aikenhead, 2006). Sutherland (2005) found that students who were able to cross the border and distinguish between Indigenous science and Western science were intrinsically motivated, valued their cultural identity, and received strong family support.

Experiential Learning

If motivation and persistence in Native American education can be associated with cultural, family, and peer influence, is there an experiential component at work as well? Are Native American students more likely to pursue math and science if they can see it in practice and see how it relates to their lives? Dewey (1968) stated a student's educational aim was based upon the activities and needs that pervaded their natural instincts or habits they had experienced in their life. The student must be able to translate these instincts or habits in the process of instruction in order to organize their capacity to learn. Experiential learning differs from traditional methods where the student is a more active participant in the learning process, rather than a passive recipient of information "deposited" by the instructor (Teixeira-Poit, Cameron, & Schulman, 2011, p. 245). Kolb and Kolb (2009a) argued experiential learning was "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (p. 298).

> *One of the reasons I had difficulty during my first year of college was the nature of the instruction. I felt that I was a passive recipient of the information that was presented in class with very little opportunity to put the information to practice. With the exception of an occasional laboratory class, I found it challenging to commit information to memory without a concrete understanding of the material; rote memorization without application. My thinking at the time was that I was not particularly good at memorizing material. Fast forward to my second attempt at college academics and I noticed a distinct change in my ability to harness the information that was presented. I was able to visualize what was being presented in class, because I was better able to grasp the physical application of what was being taught. With respect to memorization, I found that my experience in the Navy, specifically during Aviation Officer Candidate School, later during flight school, including my training as an astronaut, was that I was very capable of memorization because there was applicability to what I was learning. I knew that I would apply what I was learning in a real world environment. I would visualize or reflect on the material I was studying and act upon this knowledge in a real world environment. This was the imperative for memorization, in my failure to understand and repeat what I had learned on the ground could have very serious ramifications in flight; knowledge meant safety. I transitioned from a*

> *feeling of not be capable of learning to someone who "learned how to learn" due to my ability to grasp concepts and their applicability to my personal experience.*

Kolb and Kolb (2009a) also described experiential learning theory (ELT) as a recursive cycle where the student "learns how to learn" by "experiencing, reflecting, thinking, and acting" (p. 297). This process can transform a student from thinking they are not capable of learning to becoming someone who believes they are a "learner." (p. 297). Kolb and Kolb (2009a) also stated that one of the key aspects of ELT was the concept of "learning self-identity." (p. 304). Learning self-identity comes from a person's belief that they are a capable learner and that their focus was not on a particular goal or performance; rather, the focus was on their excitement from the process of learning (Kolb & Kolb, 2009a).

Extending the concept of self-identity and how it was related to a strong sense of self-esteem, some scholars posited feelings of inadequacy and lower self-esteem were often a result of Native American students' inability to learn when taught using the traditional Western educational model (Reyhner & Eder, 2004; Whitbeck, Hoyt, Stubben, & LaFromboise, 2001). Perhaps an educational environment that supported hands-on experiential learning would lead students to develop a self-identity that was built on a strong foundation of positive self-esteem and feelings of success in the learning environment. The review of the literature found the following four examples of experiential summer camps designed to provide students with hands-on activities and exposure to a variety of mathematical and scientific subject matter.

Summer Camp as Experiential Educational Environment

Mathematics summer camp for women. A review of science, technology, engineering, and mathematics (STEM) summer camp programs provided evidence that hands-on experiential learning can foster strong self-identities in participating students. Chacon and Soto-Johnson (2003) conducted two summer residential mathematics camps devoted entirely to high school girls. The intent of the program was to encourage the young women to continue studying mathematics by creating an exciting environment that would engage their interest in the subject matter. The researchers chose to use real mathematical content that was fun, hands-on, and in a non-traditional classroom environment that focused on cooperative learning and less competition. While most of these students were from middle to upper income brackets, the camp was offered free of charge; therefore, financial status did not preclude a student from participating. All of the students were considered academically talented since they had completed algebra I, algebra II, and geometry and were recommended by their mathematics teachers. The participants were ethnically diverse with more than half of the students being non-Caucasian. Course content included hands-on projects where students worked in a group environment using probability, statistics, and geometry. Projects utilized real world examples to convey mathematical principles. For example, the rules of probability were investigated using weighted dice and chi-squared testing to determine if the dice were fair (Chacon & Soto-Johnson, 2003, p. 277). Coupon-collecting problems were used to demonstrate random sampling and how actual sampling compared with random number tables.

The researchers used baseline and follow-on Likert surveys to assess the students' attitudes in five areas; persistence in problem solving, group work, gender roles in mathematics, understanding concepts, and confidence in mathematical abilities. The instrument's reliability was measured with a Cronbach's Alpha of .63. A one-tailed paired *t*-test with *a* = .05 was used to evaluate the responses from the pre and post surveys. Statistically significant differences were found regarding the students' attitudes on (a) whether persistence played a role in success solving mathematical problems and (b) whether group work was effective in learning mathematical concepts. In addition, a significant difference was found in how the students' viewed their ability to solve mathematical problems. The results indicated the students had a greater level of confidence in their ability to solve problems following the completion of the camp. This increased confidence was a characteristic of a positive self-identity; one of the theories that Kolb and Kolb (2009a) argued made a difference in a student's ability to learn (p. 304).

Results from the *t*-test also found that there were no statistically significant differences in attitudes regarding gender roles in mathematics, nor in the students' attitudes about their understanding of mathematical concepts. In addition to the Likert survey, journal entries were used to support the findings of the pre and post testing. Initial journal entries indicated a lack of confidence and frustration in problem solving, but journal entries at the completion of the camp indicated increased confidence and enjoyment working in a group setting. A follow-up questionnaire was distributed to all participants at the end of the second year, which indicated that the students who participated in the first year and subsequently graduated from high school, continued into college with a few taking course work required at least calculus I.

Students 'geeked' about STEM. Ivey and Quam (2009) conducted a nine weeklong summer camp for 140 middle school students with activities in aeronautics, robotics, and computer design. The camp leadership used seven key skills that were defined by Wagner (2008):

1. Critical thinking and problem solving.
2. Collaboration and leadership.
3. Agility and adaptability.
4. Initiative and entrepreneurialism.
5. Effective oral and written communication.
6. Accessing and analyzing information.
7. Curiosity and imagination.

Though each of these skills consisted of two separate entities, together they made up a set that was synergistic. For example, according to Wagner, critical thinking and problem solving were essential to remain competitive in today's global economy. Individuals must think about how to continuously improve their products and services. Using critical thinking skills, they developed methods for solving the problems regarding product improvement.

Each of the daily activities required the students to work in teams to accomplish each project. Projects were designed to require the students to utilize each of the seven skills identified by Wagner. Students worked throughout the week collaborating on a variety of projects that provided hands-on experience, which required them to be self-motivated learners who were encouraged to be creative, innovative, and productive.

While the camp leadership did not perform a quantitative analysis of the program, they did conduct a post camp evaluation where they asked participants to provide feedback on their experience. Comments from the students were extremely positive about the impact the camp had on their attitudes toward STEM. One student commented, " I did not know engineering was this much fun." Another student wrote that the camp "intensified my passion to be an engineer" (Ivey & Quam, p. 21). Parents were also asked to provide feedback on whether or not their child's attitudes toward STEM were affected by the camp. One parent stated, "I think he is looking at science and math, technology and engineering from a totally different perspective – it was a very positive experience" (Ivey & Quam, p. 21).

Electrical engineering summer academy. LoPresti, Manikas, and Kohlbeck (2010), researchers at the University of Tulsa, in Tulsa, Oklahoma conducted and analyzed two weeklong electrical engineering summer programs for middle school and high school students. The camps were designed to increase students' awareness of engineering careers through the use of hands-on projects, seminars, and tours of local industries. The overall goal was to provide students with exposure to real world engineering projects that would increase their understanding of engineering as a profession and develop their appreciation of the math and skills involved. The program also engaged middle school and high school teachers such that they could utilize these projects during the course of the academic year, providing more students with exposure to actual engineering applications and the requisite academic and professional skills associated with engineering.

Students learned basic fundamentals in a classroom setting and they were able to quickly utilize these fundamentals with actual hands-on application. Projects included the use of basic circuit components including capacitors, resistors, batteries, and switches. Students applied the knowledge they learned in the classroom by constructing circuits and conducting basic electrical measurements. As a prerequisite to constructing the circuits, they learned about digital logic and logic gates, as well as learning how to solder (LoPresti, Manikas, &

Kohlbeck, 2010). In addition to the technical skills they learned, they were also exposed to professional skills associated with engineering, including teamwork, and written and verbal communication. The program evaluation had four major objectives:

1. Students could describe the basic principles of the engineering process.
2. Students could describe specific electrical engineering problems and applications.
3. Students could learn about the principles of teamwork.
4. Students could complete projects and demonstrate and present results to others.

A formal social science quantitative analysis was not conducted, but pre- and post-questionnaires were administered and cumulative scores were calculated from the results. To evaluate whether the first two objectives were met; the researchers asked the students to respond, from one to four, to statements regarding their understanding of the basic principles of engineering, objective one. Higher scores indicated a greater understanding of the basic principles. For the second objective, multiple-choice questions were asked regarding electrical engineering applications. Higher scores indicated greater understanding of electrical engineering problems and applications. Observations and conversations with the students during the course of the week were used to ascertain if they had an understanding of teamwork and project completion, the third and fourth objectives.

Positive increases in the questionnaire scores between the pre- and post-tests were used as evidence of meeting the objectives defined by the researchers. Positive increases for answers to the questionnaire indicated that objectives one and two were met. Researchers found the third objective was met through positive student comments collected by the researchers and teachers following observations of, and discussions with, the students. The researchers and teachers did not provide any quantitative data to support their findings for the third objective so their results were based on a subjective analysis of the positive comments provided by the students. The fourth objective was met by the students' models of their projects, which they were able to present at the completion of the camp.

Though the electrical engineering summer camp met the objectives of the researchers, it would have been beneficial if a mixed methods quantitative and qualitative analysis of the program had been conducted. The researchers who evaluated the electrical engineering camp had an excellent opportunity to conduct a more rigorous quantitative analysis of the impact of hands-on experiential education on the students' interest and understanding of electrical engineering. Understanding the effects of a hands-on summer camp on inspiring students to pursue more coursework in the STEM fields from both a quantitative and qualitative perspective would add to the body of knowledge surrounding experiential learning and how a short exposure to engineering principles can have a lasting effect on students' attitudes regarding STEM.

Hands-on summer camp to attract K-12 students to engineering fields. Yilmaz, Ren, Custer, and Coleman (2010) conducted and evaluated a weeklong summer camp at Texas A&M University – Kingsville (TAMUK) designed to expose high school students to the STEM subject matter using both technical activities and hands-on engineering projects. TAMUK is located in southern Texas and serves a predominantly Hispanic community (65% of the population), a traditionally underserved minority in the STEM fields (Yilmaz, Ren, Custer, & Coleman, 2010). The main goals of the Young Engineers of South Texas (YESTexas) were to (a) expose the students to concepts in STEM and (b) to motivate them to pursue college educations in engineering. The curriculum was designed to provide hands-on activities that introduced the students to real-world engineering projects and the skill set required for design, data collection, and analysis (Yilmaz, Ren, Custer, & Coleman, 2010). Each project required approximately three hours to complete and dealt with engineering problems relative to the South Texas region: bridge building, air/water management, and Bluetooth wireless technologies were some of the projects the students were exposed to in the curriculum.

Team building was a central theme of the camp with three to four students per team as well as one to two graduate student mentors. Brief lectures provided background material for each project, but the majority of the time was spent in a hands-on environment dedicated to the project. For example, in the classroom, students learned the principles behind, and the operation of, air pollutant monitoring equipment. The students proceeded to use the equipment to assess the level of hydrocarbon emissions from the exhaust of a car running in a parking lot at TAMUK.

In order to determine if the camp met the goals of the researchers, student evaluations were conducted daily through oral communication and discussion groups. Additionally, six-part surveys were administered which included

- demographic information (voluntary);
- recruitment methods;
- statements meant to assess the impact of the program on the students' future educational plans;
- a 4-point Likert type scale meant to assess the impact of the program on the students' academic life;
- suggestions for improvement of the program; and
- optional testimonials about the program.

Results indicated that the goals of the program were achieved with the majority of students; 28 out of 30 expressed an interest in pursuing engineering as a college and career choice. Though the program achieved the goals set by the researchers, the data collection and analysis were correlational, but not experimental. Therefore, a cause and effect relationship could not be established given that randomization, manipulation, and comparison were not conducted. In addition, expressing an interest in pursuing an education in engineering was not the same as actually accomplishing the same. A longitudinal study to capture whether or not the students enrolled in coursework consistent with an engineering curriculum would have provided substantive data to support the success of the summer program.

Summary

If the United States is to remain a leader in the areas of Science, Technology, Engineering, and Mathematics (STEM), it is imperative the number of college graduates with degrees in the STEM fields increase to meet the demands of a technological global economy. The challenge is finding approaches that motivate students to study course work in their high school years, such that they can successfully enter into a post-secondary education and be capable of completing the rigorous academics associated with degrees in STEM. Historically, White males have been the predominant ethnic group that earned degrees in the STEM fields, but the ever-increasing number of minorities in the United States provides a larger community for STEM graduates. Therefore, finding approaches that motivate and inspire traditionally underserved and underrepresented minorities to study in the STEM fields is essential.

While most of the summer programs in the literature review sought to evaluate the participants' level of interest in STEM, only one conducted a formal social-science quantitative analysis of the data acquired pre and post program. The remainder of the programs captured numeric and anecdotal data that indicated interest in STEM, but not in a manner that met the criteria for experimental or quasi-experimental design. Each program presented opportunities for the students to learn about engineering and science principles and applications through experiential methods and the researchers attempted to correlate this to students' increased interest in STEM. It would have been beneficial if the researchers had conducted longitudinal studies that followed these students through high school to determine any long-term effects of the programs on the students' motivation to pursue STEM.

Chapter 3: Methodology

Background

Though this chapter is titled *Methodology,* it is important to distinguish that the title only describes one element of the research conducted in this study. Three elements actually exist within the foundation of this research: methodology, design, and methods. *Methodology*, according to Creswell and Plano Clark (2007), is the philosophical framework underlying the direction and collection of data. The *design* is the "plan of action" connecting the philosophical framework to the methods used to conduct the study (Creswell & Plano Clark, 2007, p. 4). The specific manner in which the data are collected is defined as the *methods* of the research. This chapter will describe the mixed-methods research conducted in this study from the aspect of each of the three components; methodology, design, and methods. In addition, this chapter will describe the participants used in the study, the limitations of the study, the trustworthiness, and my personal bias.

Methodology

The philosophical framework for this study was pragmatic. In keeping with the philosophic worldview of Dewey, Piaget, and Lewin, a pragmatic approach to this research entailed there were multiple realities or perspectives involved in the study. According to Creswell and Plano Clark (2007) a combination of quantitative and qualitative data allowed a practical epistemology and multiplicative axiology that the researcher was distant, impartial, and unbiased (quantitative) and biased in the sense that the researcher brought a personal perspective and motivation to the qualitative phase of the research. Johnson and Onwuegbuzie (2004) view mixed methods research as one that was "inclusive, pluralistic, and complementary" (p. 17). Therefore, use of a pragmatic worldview allowed me to design a study that incorporated both a quantitative phase that sought to deduce, through an unbiased lens, whether or not the summer program had an immediate effect on the participants. From a practical perspective, I understood that the use of an unbiased instrument would not provide a complete picture of the program results over the long term. Subsequently, it was necessary to include the voices of the participants in determining whether or not the long term effects of the program could be determined through the use of a qualitative case study. My intention was to use the results of the qualitative phase to supplement the findings of the quantitative phase.

Explanatory Sequential Mixed-Methods Design

Mixed methods research design involved the “collecting, analyzing and mixing of qualitative and quantitative approaches” under the premise that “in combination provides a better understanding of research problems than either approach alone” (Creswell & Plano Clark, 2007, p. 18). Creswell and Plano Clark (2007) stated that the intent of quantitative research and the data therein, sought to deductively support or refute a theory through statistical analysis. Conversely, qualitative research and the associated data were designed to understand or give meaning to a phenomenon, inductively (Creswell & Plano Clark, 2010). Rather than discuss which research method was better than the other, Allwood (2012) argued that the context in which the research was used and an evaluation of the pros and cons of a particular method, was the best approach to justifying the use of either method. With that perspective in mind, this study required use of both methodologies since analysis of the quantitative data alone would not be sufficient to ascertain whether a cause and effect relationship existed between the program and the increased interest in the participants regarding STEM, over a multi-year timeframe. Data from the baseline and follow-up surveys could provide statistically significant results regarding the participants' attitudes about STEM immediately following the program, but to extrapolate those results to justify their participation in higher level math or science courses two to three years later, would be inappropriate.

The use of a qualitative methodology to enhance the results derived from the quantitative portion of the research, by adding a narrative to the numerical data, was the intent of this study's design. Creswell and Plano Clark (2007) argued the use of qualitative data enriched and explained the outcome of quantitative data. As such, this study used an explanatory sequential design where the first phase consisted of the collection and analysis of baseline and follow-up surveys completed at the beginning and end of the 2010 IMU NASA SOI program. The second phase consisted of a qualitative case study conducted three years following the conclusion of the summer program. The case study consisted of individual interviews with the original participants of the 2010 summer program. Data from the quantitative phase was analyzed and used to develop a set of open-ended questions designed to understand and explain whether the IMU NASA SOI program was beneficial in the long-term toward changing or strengthening the participants' attitudes regarding STEM. Figure 3 provides a model of the explanatory sequential mixed methods design (Creswell & Plano Clark, 2007, p. 73).

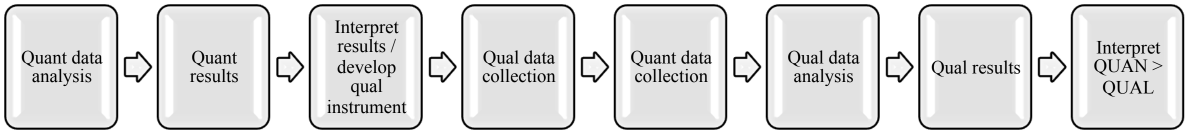

Figure 3. Explanatory sequential mixed methods design

Methods

Quantitative. In this study the use of quantitative methods were necessary for analyzing the results of the baseline and follow-up survey instruments administered to the participants at the beginning and the completion of the summer program. The instruments were a compilation of two existing surveys. The first existing survey was the Modified Attitudes Toward Science Inventory (MATSI) and the second existing survey was the Test of Science Related Attitudes (TOSRA) (Weinburgh & Steele, 2000; Fraser, 1981). The baseline and follow-up surveys developed by NASA and Abt Associates used selected questions from the MATSI and TOSRA, with demographic questions included in the baseline survey.

Modified Attitudes Toward Science Inventory (MATSI). The MATSI was a modified version of the Attitudes Toward Science Inventory; version a (ATSI:a), a 48-item Likert instrument that measured students' attitudes regarding their anxiety, self-concept, and desire and values regarding science. The inventory also measured the students' perceptions of their science teacher. The modification was developed by Weinburgh and Steele (2000) in order to improve the reliability of the instrument (Cronbach's Alpha of 0.70) with respect to African-American students in the 5^{th} grade by decreasing the test length from 48 to 25 items. The authors decreased the test length to accommodate younger children's limited attention span and to shorten administrative time associated with the test (Weinburgh & Steele, 2000).

Questions on the survey were measured on a scale from 1 to 5 from Strongly Disagree to Strongly Agree. Sample questions included:

	SD SA
1. Science is easy for me.	(1) (2) (3) (4) (5)
2. No matter how hard I try I cannot understand science.	(1) (2) (3) (4) (5)
3. I do not do very well in science.	(1) (2) (3) (4) (5)

The baseline survey developed by NASA and Abt for the SOI used four questions from the MATSI. Additionally, since the MATSI was designed to measure attitudes toward science only, NASA and Abt modified two MATSI questions to address math rather than science.

Test of Science Related Attitudes (TOSRA). The second instrument NASA and Abt used in the development of the SOI baseline survey was the Test of Science Related Attitudes (TOSRA). This instrument consisted of 70 items on a 5-point Likert scale, from (5) Strongly Agree (SA) to (1) Strongly Disagree (SD), which assessed attitudes related to science along seven different dimensions; the social implications of science, enjoyment of science lessons, career interest in science, leisure interest in science, normality of scientists, attitudes toward scientific inquiry, and adoption of scientific attitudes (Fraser, 1981). Reliability of the instrument over a ten-year period had a Cronbach's Alpha of 0.84. The test, retest reliability was 0.78. Sample questions included:

1. I would like to belong to a science club.	(5) (4) (3) (2) (1)
2. Science lessons bore me.	(5) (4) (3) (2) (1)
3. A career in science would be interesting.	(5) (4) (3) (2) (1)

Though the TOSRA was designed and implemented in Australia, it was also administered in the United States and Fraser claimed to have cross-cultural validity due to consistent values for Cronbach's Alpha and mean correlation between the Australian and United States sites (Fraser, 1981).

NASA/Abt SOI instrument. The instrument NASA and Abt utilized for the baseline and follow-up surveys was a modified combination of the MATSI and TOSRA. A total of 18 items were included in the baseline instrument: Thirteen demographic questions and 5 questions with subsets of multiple 5-point Likert items. Question number 14 of the NASA/ABT SOI instrument, consisted of 32 Likert items and dealt specifically with the students' attitudes toward math and science. Four of the 32 Likert items were taken from the MATSI, two of which were identical in wording, except the word "science" was changed to "math" in order to survey the participants' attitude with respect to mathematics. The remaining 28 Likert items were taken from the TOSRA, 16 of which were modified to address math as well as science. The remaining questions in the survey, questions 15 through 18, consisted of multiple Likert responses that pertained to parental, guardian, or peer involvement with the student during the past school year. It was not clear where these questions were derived and therefore it could be determined if there s any validity or reliability associated with their use in the survey. Neither NASA nor Abt provided an explanation for their use in the survey. The follow-up survey consisted of only the 32 Likert items asked in question number 14 of the baseline survey. The demographic and parental/guardian/peer involvement questions were not included in the follow-up survey.

For the purposes of this study, only the 32 Likert items in question 14 were analyzed using a factorial analysis of variance (ANOVA). Questions 1-13 were used for demographic purposes and questions 15 – 18 were omitted from the quantitative analysis since they did not pertain to the students' attitudes regarding math or science. The 32 Likert items of question 14, used in the quantitative analysis, are provided in Appendix A.

Data collection. The NASA/Abt SOI baseline survey was administered to 21 students on the morning of the first day of the program. The follow-up survey was administered five days later, on the last day of the program. A total of 17 students remained at completion of the program and completed the follow-on survey. For the purposes of this study, only data from the 17 students who completed both surveys were analyzed. In some cases, students did not return to take the follow-on survey; as a result, their data was removed from the analysis. In the cases were students answered both the baseline and follow-up surveys, but skipped some of the questions, their answers were evaluated to determine if they answered more than 90% of the questions. If the missing answers exceeded 10% of the total questions asked, the respective participant's responses were removed from the data analysis. Bennett (2001) argued that statistical analysis was biased if more than 10% of the data set was missing. For those cases where the student answered more than 90% of the questions, but still failed to answer some of the questions, SPSS was used to determine if there were patterns in the missing data using Little's Missing Completely At Random (MCAR) test (Little & Rubins, 1989).

Data analysis. The 32 questions of the baseline and follow-up surveys consisted of both positive and negative questions. Seventeen of the questions were in the negative form and 15 questions were positive. For example, a negative question would be, "I do not do very well in science." In order to create an overall cumulative score, which indicated a student's positive attitude toward STEM, each of the 17 negative questions were reworded to be positive and the answer provided by the participant was correspondingly reversed. For example, if a student answered the question, "I do not do very well in science," with the response "Disagree," a positive rewording of the question would be, "I do very well in science," with the response changed to "Agree." The responses from the baseline and follow-up surveys were assigned numeric values that corresponded to a specific answer. A value of one (1) was assigned to Strongly Disagree, a value of two (2) was assigned to Disagree, a value of three (3) was assigned to Uncertain, a value of four (4) was assigned to Agree, and a value of five (5) was assigned to Strongly Agree. This allowed for a total score, summing the answers to each question, which indicated a participant's positive attitude toward STEM. If a participant's total score for the follow-up survey were greater than the score for the baseline survey, the result would represent a more positive attitude toward STEM following the SOI program.

In order to measure if the baseline and follow-up surveys demonstrated the students exhibited a change in their attitudes regarding math and science, three analyses were performed. First, single subject research design using visual analysis was conducted in order to determine if there was a change in a specific individual's attitude toward math and science by comparing mean scores between the baseline and follow-up surveys (Nock, Michel, & Photos, 2007; Park, Marascuilo, & Gaylord-Ross, 1990). Second, a paired samples *t*-test was conducted to determine if statistically significant differences in the mean scores of the participants existed and if they would correlate with the results of the visual analysis. And third, I conducted a 2 X 2 ANOVA to measure the effects of the IMU NASA SOI program across time, gender, and the interaction of time and gender. The primary assumptions in the use of inferential statistics are random sampling, observation independence, normality of frequency distribution, and equal variances (Chen & Zhu, 2001; Trochim & Donnelly, 2008). With respect to the assumption of random sampling, in the case of this study, the students in the IMU NASA SOI were volunteers and the sample was one of convenience rather than random. Therefore, the results of these analyses cannot be generalized to a larger population. I chose to use these statistical tools in order to quantify the changes for these students with the full knowledge that I could generalize the results to a larger population. Instead, my intention was to determine whether the quantitative results for these particular students correlated with the findings from their narratives in the qualitative case study.

Single-subject analysis. In order to ascertain whether each individual in this study demonstrated a change in their attitude with respect to math and science, it was necessary to analyze the results of the IMU NASA SOI program baseline and follow-up surveys using single-subject research methods (Egel & Berthold, 2010; Kromrey & Foster-Johson, 1996; Nock, Michel, & Photos, 2007; Park, Marascuilo, & Gaylord-Ross, 1990). The independent variable in the single-subject analysis was the IMU NASA SOI program as an intervention. The dependent variable was student's attitude toward math and science as measured from the results of the baseline and follow-up surveys. Descriptive statistics for each student were determined using SPSS analysis software. The mean scores for the two surveys were plotted and analyzed graphically to determine if a change in the mean scores were observed (Egel & Berthold, 2010; Nock, Michel, & Photos, 2007; Park, Marascuilo, & Gaylord-Ross, 1990). Visual analysis of graphic data was considered the most frequent method of analysis for single-subject researchers. (Egel & Barthold, 2010). In addition, Kromrey & Foster-Johnson (1996) argued that visual analysis of the data could be supplemented with inferential statistics because "low level" effects of the treatment might not be detectable through visual inspection (p. 75). Therefore, Cohen's *d*, was calculated to determine what extent the program had an effect on the students that participated in the program (Kromey & Foster-Johnson, 1996).

Paired samples t-test. Since visual analysis was used as a method to determine if the dependent variable was affected by the independent variable (intervention) for single-subjects, I chose to use the paired samples *t*-test as an additional analytic tool to actually quantify the effect of the IMU NASA SOI program and ascertain if a statistically significant change occurred in the student's attitude toward math and science. Even though inferential statistics are not normally used to measure single-subject studies due to the inherent non-independence of a single subject, the use of a paired samples *t*-test would provide the necessary results to calculate the effect size as well as a statistically significant result relative to a theoretical population (Beeson & Robey, 2006). The paired sample consisted of the baseline and follow-up scores for each individual. The dependent variable was the student's attitude toward STEM measured before and after the IMU NASA SOI program in the form of their Likert responses to each question in the surveys. While Likert responses are normally classified as ordinal, in the case of this study they were treated as a continuous variable as a measure of the student's attitude toward STEM (Lund & Lund, 2013a). The independent variable was the IMU NASA SOI program. The data were evaluated to determine if there were significant outliers and if the differences in the dependent variable were normally distributed. The null and alternative hypotheses were:

1. H_0: The mean score for each student did not vary between the baseline and follow-up surveys.

2. H_1: The mean scores for each student did vary between the baseline and follow-up surveys.

Factorial Analysis of Variance (ANOVA). In addition to evaluating the effect of the program on specific students, a 2 X 2 ANOVA using SPSS was conducted to determine if there was a significant difference between genders regarding the students' attitudes toward math and science following participation in the IMU SOI program. The independent variables were time and gender. The dependent variables were the students' scores, representing their attitude regarding science and mathematics. To calculate 2 X 2 ANOVA, the within-subjects factor was *time* with two levels, baseline and follow-up. The between-subjects factor was *gender* with two levels, male and female. In order to conduct an ANOVA, three assumptions regarding the data were required (Lund & Lund, 2013b):

1. There were no outliers in the data
2. The data was normally distributed.
3. The data had equal variance (homogeneity of variance)

The null and alternative hypotheses were:

1. H_{01}: The mean difference in the participants' attitude toward science and mathematics before and after the SOI program did not vary over time.
2. H_{02}: The mean difference in the participants' attitude toward science and mathematics before and after the SOI program did not vary between genders.
3. H_{03}: The mean difference in the participants' attitude toward science and mathematics before and after the SOI program did not vary between gender and time.
4. H_{11}: The mean difference in the participants' attitude toward science and mathematics before and after the SOI program did vary over time.

5. H_{12}: The mean difference in the participants' attitude toward science and mathematics before and after the SOI program did vary between gender.

6. H_{13}: The mean difference in the participants' attitude toward science and mathematics before and after the SOI program did vary between gender and time.

Qualitative. The qualitative portion of the study was an explanatory case study designed to determine if a causal link existed between the experiential education methodology of the IMU NASA SOI and the effect on the participants and their desire to study courses in the STEM fields. The intent of the case study was to capture the stories of the participants and relate those stories to the results from the quantitative study and determine if there were correlations in the data. Case study methodology allowed me the opportunity to uncover the unique stories that existed among the participants of the study and to more fully investigate the factors that quantitative methodology cannot capture (Hays, 2004; Timmons & Cairns, 2010). One of the benefits of a case study is the results can be evaluated by the readers of the study who can draw their own opinions based upon their own experience (Hays, 2004).

Data collection. A series of 25 open-ended questions were presented to the student participants to determine if their experience in the summer program had the effect of increasing their interest in math and science such that they were motivated to study additional and perhaps more challenging math and science classes during high school. The case study questions are presented in Appendix B. Sixteen one-half to one hour interviews were conducted over a one-week period on the campus of the Duck Valley Combined School during school hours from December 10th through the 13th, 2013. One interview was conducted over the phone during the month of May 2014, after one student returned to school who was not in attendance during the month of December. Each participant was asked to sign a Letter of Consent form that included a signature from a parent or legal guardian, given that each student participant was a minor. A letter of intent was submitted to the Shoshone-Paiute Business Council to obtain their approval prior to the start of the research. Additionally, I conducted a presentation to the Duck Valley community, which outlined my background as well as the purpose and conduct of the research. The University of Idaho Institutional Review Board approved the research on November 14, 2013, appendix D.

Data analysis. The answers to the case study questions were compared with the results of the quantitative data to determine if there were correlations in the data. Results from the analyses of the case study responses were coded in themes that arose from the narratives. Coding of the data was accomplished using the NVivo 10 for Windows qualitative analysis program. Additionally, I conducted member checks by asking each participant to review the results of their respective interview and validate the data.

The students' interviews were transcribed into narratives, designed to capture each student's story. The participants' names were changed and alias names were used in the development of each narrative. During member checks, the students were asked to read their story, including the use of an alias, and provide feedback to me on whether or not I accurately captured the story as transcribed from the audio or written interview. At the completion of the member checks, only three students requested changes to their respective narrative. One student asked for me to add one element to a description of their participation with a family member in the construction of their home, rather than being described as an observer to the construction. Two students asked that their alias name be changed to one of their choosing.

Limitations

For the quantitative portion of this study, the single most critical limitation was the use of a sample of convenience. One of the assumptions for conducting inferential statistics was that the sample studied was chosen at random from the population of interest (Trochim & Donnelly, 2008). The use of a random sample adds strength to external validity of the research and allows the findings to be generalized to the population of interest (Trochim & Donnelly, 2008). Campbell (1986), as referenced by Trochim and Donnelly (2008), argued that the use of "proximal similarity" was an alternative means of generalizing the findings to a population of interest (Trochim & Donnelly, 2008, p. 35). The "gradients of similarity" between the sample for this study and a similar population would require a context that was similar in place (rural Indian reservation), people (Native American students from middle school to high school), setting (voluntarily participation in a STEM based summer program), and time (students currently enrolled in primary education). The defined context of place, people, setting, and time defines the theoretical population for the convenient sample in this study.

For the qualitative portion of this study, it was understood that the participants might have chosen to answer my questions in a manner they felt I wanted to hear, rather than how they actually felt. While that possibility may have existed, I believed that the participants were being honest in their answers and expressed their thoughts without bias toward my personal opinions.

Trustworthiness

In order for the qualitative portion of this study to meet standards for internal validity, external validity, reliability, and objectivity, it was essential that I identify the criteria by which the study was measured, that is, what was the "truth value" of the study (Lincoln & Guba, 1985, p. 290). Marshall and Rossman (2006, p. 200) and Shenton (2004) cite the work of Lincoln and Guba (1985) and their four constructs, which are necessary for a qualitative study to meet the "criteria of soundness" for trustworthiness in research.

The first construct regards the *credibility* of the findings for the study, that is, by what criteria were the findings judged? Did the study measure what it was intended to measure? Trochim and Donnelly (2008) defined *credibility* as the establishment of believability in the results of the research from the perspective of the participant of the study. According to Marshall and Rossman (2006), credibility of the qualitative data came from the complexity of the process and that the inquiry was conducted in a manner that fully incorporated the data within the boundaries and limitations set by the researcher (p. 201).

In keeping with the recommendations of Shenton (2004), respective of Lincoln and Guba's (1985) constructs for credibility, the following provisions were utilized in the conduct of this study:

1. Well-established methods were used in the collection of data. Specific procedures were employed in the method of open-ended questioning for each individual interviewed. Interview questions were kept consistent across each interview. The time allotted for each interview was consistent.
2. Familiarity was developed with the participants of the study. Prior to individual interviews, I presented the proposed study to the community of the Duck Valley Indian Reservation, to include receiving permission from the tribal business council. The formal presentation was designed to introduce myself to the community, establish my personal credibility, and explain the purpose and conduct of the research.

3. Triangulation of data. The findings from the individual interviews were compared to findings from the quantitative surveys and used to establish common themes and viewpoints across the spectrum of the participants.
4. Member checks. Participants reviewed the qualitative data, in the form of a narrative, to validate my transcription and interpretation of the individual interviews.
5. Peer scrutiny. Members from the IMU NASA SOI program team were invited to review the survey questions as well as the resulting data, consistent with the University of Idaho Institutional Review Board guidelines, in order to provide feedback by challenging assumptions and findings in an effort to help strengthen the study design.
6. Use of researcher's "reflective commentary." I reflected upon my personal experience as it related to the data obtained in the interviews. Reflective commentary allowed me the opportunity to analyze the data from the perspective of my personal experience and correlate to the conclusions of the study.

The second construct was the *transferability* of the research. That is, could the results of the study have applicability to similar groups in similar circumstances? In qualitative research *transferability* was akin to *generalizability* in quantitative research. This study's findings identified the effects on this particular sample of students, but were not considered transferable to another sample unless the same set of boundaries and conditions were applied in the course of a subsequent study. Were the students exposed to the same material, taught in a similar manner by teachers that are engaged and motivated? Was the material presented in the same timeframe as the original study? Were the students at the same level of proficiency in math or science as the original study sample? The transferability of a qualitative study has been one of the major weaknesses as perceived by some in the research community, particularly post-positivistic researchers (Marshall & Rossman, 2006). Transferability of the findings of this research relies on the similarity of parameters between this study and subsequent studies of a similar nature. According to Trochim and Donnelly (2008), the transference of the study was best understood and judged by the person who transferred the results to a different context. The concept of transferability in quantitative research was analogous to the concept of proximal similarity with respect to generalizability of the study's findings to a theoretical population. (Campbell, 1986; Trochim & Donnelly, 2008).

The third construct deals with the *dependability* of the research. The *dependability* of qualitative research was similar to *reliability* in quantitative research (Trochim &Donnelly, 2008). Were the results of the research capable of withstanding changing conditions over time in a non-static social environment (Marshall & Rossman, 2006)? Are the results of this research repeatable in another setting? According to Trochim and Donnelly (2008), the *dependability* of the research was dependent on the ability of the researcher to properly describe the conditions under which a study was conducted and to accurately describe how the conditions may have changed from the original study. In the case of this study, I accurately documented the conditions under which the study was conducted, i.e., the interview setting, length of interviews, and the number and type of questions, such that subsequent research can duplicate the conduct of the study.

The fourth construct deals with the *confirmability* of the study. That is, to what degree could other researchers corroborate or confirm the results of the study (Trochim & Donnelly, 2008)? In order to ensure *confirmability* I properly documented the manner in which the data was obtained and analyzed. After which I conducted a data audit by repeating the data analysis and verifying that proper data collection and analysis was conducted.

Researcher Bias

I admit to having a bias with respect to motivation in education, based upon my personal experience before, during, and after college. As a student that lacked motivation during my freshman year, I acknowledged the importance of experiential based learning as a method for motivating and inspiring me to pursue further education in science and engineering. Based in part to positive role-models with expertise in engineering as well as hands-on experience working in the field of engineering, I was able to bridge a gap between theory and practice, in much the same way that Cajete (1999) argued students learn through the application of practical skills in their experience and observation. As a registered member of the Chickasaw Nation, a former Naval Aviator, test pilot, and astronaut, I have a bias toward the success of Native American students in the fields of science and engineering. I also served on the board of directors for three separate non-profit organizations whose strategic foci were dedicated to the success of Native American students in STEM, therefore I was not only personally biased, but maintained a professional bias as well. I understood that while I may have wished for the outcomes to be positive with respect to the results of this study, I harbored no illusion regarding the challenges faced by Native American students in an educational system that was based on a Western educational paradigm.

Summary

The IMU NASA SOI targeted populations, primarily Native Americans, which were underrepresented in the STEM fields. The IMU NASA SOI was designed to provide a framework to motivate and inspire Native American students through hands-on experiential education. Using a mixed-methods approach, I sought to determine if the IMU NASA SOI and its use of hands-on experiential curriculum based on NASA educational material, motivated and inspired students to pursue academics that are STEM focused. Through the use of quantitative data to evaluate the short-term experience of the students as well as qualitative data to evaluate the longitudinal effects of the IMU NASA SOI, this study sought to determine if the IMU NASA SOI was effective in achieving the goal of changing the attitudes of Native American students on the Duck Valley Indian Reservation with respect to science and mathematics in a positive direction.

Chapter 4: Findings

Overview

Chapter IV presents the analyses of quantitative data gathered from the baseline and follow-up surveys administered during the one-week IMU NASA SOI program in 2010 and analyses of qualitative data collected during the week of December 10th, 2013. The qualitative data are presented in the form of narratives developed from transcribed interviews conducted with 17 participants of the original IMU NASA SOI program and still in attendance at the Owyhee Combined School on the Duck Valley Indian Reservation.

Quantitative Data

Collection. Quantitative data were collected during the week of July 5th, 2010. The baseline survey was administered on Monday morning, the 5th, and the follow-on survey was administered on Friday, the 9th. Twenty-one participants answered the baseline survey and 17 participants answered the follow-up survey. The responses from the baseline and follow-up surveys were assigned numeric values that corresponded to a specific answer. A value of one (1) was assigned to Strongly Disagree, a value of two (2) was assigned to Disagree, a value of three (3) was assigned to Uncertain, a value of four (4) was assigned to Agree, and a value of five (5) was assigned to Strongly Agree.

Analysis. The baseline and follow-up surveys contained 32 identical questions, some in the form of positive questions and some in the form of negative questions. In order to score the data as a measure of attitude in science and mathematics, the negative questions were transformed into positive questions and the answers were correspondingly reversed. For example, if a question asked, “I do not do very well in science” and the answer was “agree,” the question was changed to “I do very well in science” and the answer was changed to "disagree." Seventeen questions were in negative form and 15 were in positive form. After all of the questions and answers were transformed into positive questions and responses, each individual response value was input into SPSS under variable names corresponding to each question in the baseline and follow-up surveys. Two additional variables were assigned as "baseline" and follow-up" and represented the total of the individual response values. The participants were identified with respect to gender with the value of "1" assigned as "male" and "2" assigned as "female" and the variable was assigned as "Gender."

Seventeen students answered both the baseline and follow-up surveys. Two of the students that participated in the program subsequently moved and were not included in the qualitative phase, but their baseline and follow-up surveys were analyzed in the quantitative phase. Additionally, two of the students that participated in the qualitative phase did not complete their baseline and follow-up surveys and they were subsequently removed from the quantitative phase. Only one of the 17 students that participated in both surveys failed to answer more than 90% of the questions and was correspondingly removed from the analysis. The remaining 16 students answered more than 90% of the questions, but there were still missing responses to the questions. The Missing Value Analysis function of SPSS was run to determine if the values missing were completely at random. The Missing Value Analysis function used Little's Missing Completely at Random (MCAR) test to calculate a chi square statistic to indicate whether the missing values are completely at random (Little & Rubins, 1989). The null hypothesis for the MCAR test was the data are missing completely at random. The significance level for Little's MCAR test was set at $\alpha = .05$ and the test resulted in a $\chi^2(501)=.000$, $p > .05$, therefore, the null hypothesis was retained.

Results. ***Single-subject visual analysis.*** A single-subject visual analysis of the baseline and follow-up mean scores was performed for each student in the study. The descriptive statistics for each student were calculated using SPSS and the mean scores were plotted to visually to compare whether there was a change in mean scores from the baseline to the follow-up survey. The descriptive statistics are provided in Table 1.

Table 1

Single-Subject Descriptive Statistics

Student	N	Baseline Mean (SD)	Follow-up Mean (SD)	Difference	Effect Size (*d*)
Skyler	32	3.50 (1.48)	3.22 (1.64)	-.28	-.19
Thomas	32	3.84 (1.39)	3.53 (0.76)	-.31	-.22
Denise	332	2.66 (1.15)	3.44 (0.78)	.78	.68
Carmen	32	3.94 (0.84)	3.63 (0.71)	-.31	-.37
Heidi	332	2.91 (1.30)	3.47 (1.63)	.56	.43
Rose	32	4.59 (0.84)	4.38 (0.66)	-.22	-.26
Kate	32	3.47 (.1.08)	3.19 (1.26)	-.28	-.26
Jerry	32	2.94 (1.56)	3.07 (1.27)	.13	.08
Bob	32	3.91 (0.30)	4.00 (0.00)	.09	.32
Abby	32	3.50 (1.14)	3.41 (1.34)	-.09	-.08
Steve	32	3.47 (1.16)	3.31 (0.78)	-.16	-.13
Ajay	32	3.19 (1.42)	3.47 (1.39)	.28	.20
Becky	32	3.81 (1.55)	3.36 (1.77)	-.46	-.29
Stacey	32	3.00 (0.95)	2.97 1.18)	-.03	-.03
Sandy	32	4.25 (1.02)	4.16 (1.23)	-.09	-.09
Nicky	32	2.75 (1.30)	2.47 1.11)	-.28	-.22

The mean scores for each student's baseline and follow-up surveys are shown in Figure 4.

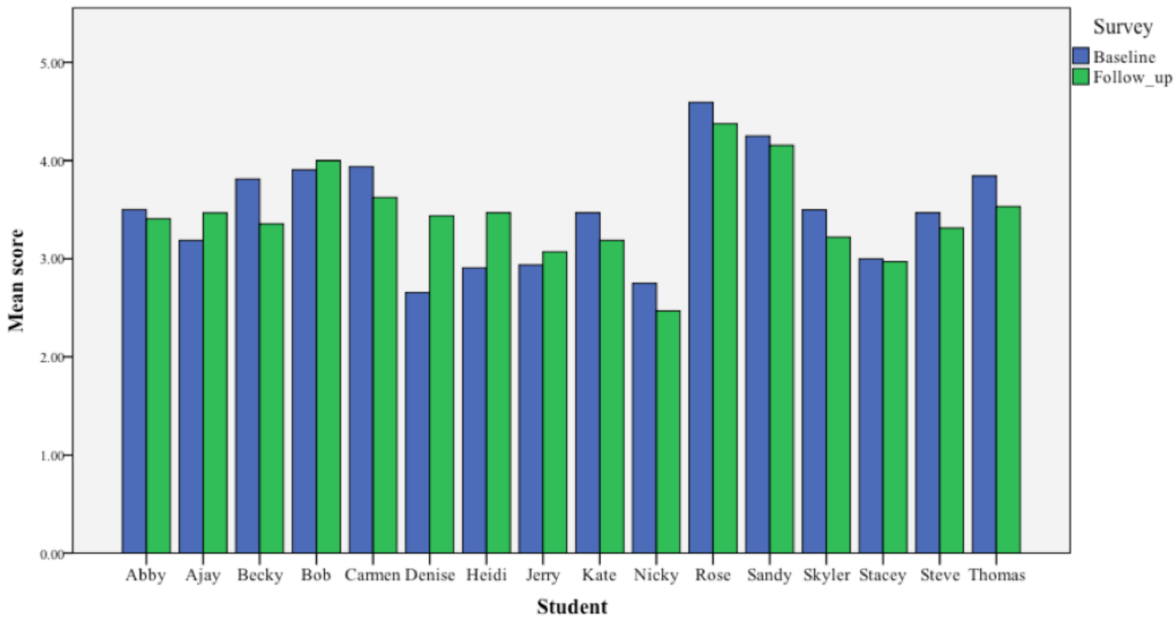

Figure 4. Baseline and follow-up mean scores per student

A visual inspection of the graph indicated that two of the students presented a larger change from their baseline mean scores to their follow-up mean scores: Denise, and Heidi. Cohen's *d* was calculated for each student and the results correlated with Denise and Heidi demonstrating the largest effect sizes of the participants in the study. The calculated effect sizes of 0.43 and 0.68 represented medium effects of the program on Heidi and Denise, respectively (Lund & Lund, 2013a)

Paired samples t-test. A paired samples *t*-test was computed to compare whether or not a statistically significant difference existed between the mean scores for each student regarding their attitude toward STEM following the SOI program. Outliers and normal distribution of difference scores from the baseline and follow-up surveys were verified visually through inspection of their respective histograms, normal Q-Q plots, and box plots. The Shapiro-Wilks test indicated the data were normally distributed. The results of the paired sample *t*-test are presented in Table 2.

Table 2

Paired t-test Results

Student	Mean Diff	SD	*t*	df	Sig (2-tailed)	Effect Size (*d*)
Skyler	-0.28	1.17	-1.35	31	.19	-0.24
Thomas	-0.31	1.33	-1.33	31	.19	-0.23
Denise	0.78	1.10	4.02	31	.00	0.71
Carmen	-0.31	0.69	-2.55	31	.02	-0.45
Heidi	0.56	1.54	2.06	31	.05	0.36
Rose	-0.22	0.94	-1.31	31	.20	-0.23
Kate	-0.28	1.12	-1.42	31	.17	-0.25
Jerry	0.13	1.09	0.68	31	.50	0.12
Bob	0.09	0.30	1.80	31	.08	0.32
Abby	-0.09	1.44	-0.37	31	.72	-0.06
Steve	-0.16	1.05	-0.84	31	.41	-0.15
Ajay	0.28	2.07	0.77	31	.45	0.14
Becky	-0.46	1.69	-1.53	31	.14	-0.27
Stacey	-0.03	1.06	-0.17	31	.87	-0.03
Sandy	-0.09	1.33	-0.40	31	.69	-0.07
Nicky	-0.28	1.22	-1.20	31	.20	-0.23

When compared to the results from the single-subject visual analysis, the data from the paired sample *t*-test correlated with the findings that Denise and Heidi demonstrated the most significant positive change in their attitudes toward math and science. The data also indicated Becky and Carmen demonstrated the largest negative changes in attitude toward math and science. A comparison of the effect sizes for both the single-subject analysis and the paired sample *t*-test are similar in magnitude. For Denise, the mean on the baseline was 2.66 (*sd* = 1.15) and the mean on the follow-up was 3.44 (*sd* = 0.72). For Heidi, the mean for the baseline was 2.91 (*sd* = 1.30) and the mean for the follow-up was 3.47 (*sd* = 1.63). For Carmen, the mean on the baseline was 3.94 (*sd* = 0.84) and the mean for the follow-up was 3.62 (*sd* = 0.71). For Becky, the mean on the baseline was 3.81 (*sd* = 1.55) and the mean for the follow-up was 3.36 (*sd* = 1.77). A significant increase in attitude for Denise and Heidi from baseline to follow-up were found (t (31) = 4.02, $p < 0.05$, $d = 0.71$) and (t (31) = 2.06, $p < 0.05$, $d = 0.36$), respectively. However, a significant decrease in attitude was found for Carmen (t (31) = - 2.55, $p < 0.05$, $d = -0.45$). The decrease for Becky was not significant (t (31) = -1.53, $p > 0.05$ For the 16 participants that were analyzed in the paired *t*-test, only three had statistically significant changes in the mean for their answers to the questions measuring attitudes regarding science and math. It was interesting to note that each of these students were female. The males in the group did not demonstrate statistically significant changes in their attitude regarding science and mathematics following the summer program. Therefore, the null hypothesis was retained for thirteen students and rejected for three students.

Factorial ANOVA. A two-way ANOVA was conducted to measure if there were statistically significant changes in the participants' attitudes regarding science and mathematics. The first factor, *time*, consisted of two levels; baseline and follow_up. The second factor, *gender*, consisted of two levels; male and female. All effects were considered statistically significant at the 0.05 significance level. Outliers and normal distribution of the data for baseline and follow-up data overall and by gender were verified visually through inspection of their respective histograms, normal Q-Q plots, and box plots. A Shapiro-Wilk's test (p > .05) indicated a normally distributed data for overall baseline and follow-up and when analyzed by gender. A Levene's test verified the homogeneity of variance in the sample data (p > .05) (Martin & Bridgmon, 2012). A Pearson Chi Square test for independence test yielded non-significant results for gender * baseline of χ^2 = (14, N = 16) = 13.67, $p > 0.05$ and for gender * follow-up of χ^2 = (15, N = 16) = 16.0, $p > 0.05$.The descriptive statistics for the participants' cumulative attitude scores are provided in Table 3.

Table 3

ANOVA Descriptive Statistics

Scores	Gender	N	Mean (SE)	SD	Skewness (SE)	Kurtosis (SE)
Baseline	Male	5	111.00 (5.96)	13.32	-0.21 (0.91)	-2.08 (2.00)
	Female	11	111.63 (6.04)	20.05	0.31 (0.66)	-0.80 (1.28)
	Total	16	111.43 (4.44)	17.76	0.28 (0.56)	-0.57 (1.09)
Follow_up	Male	5	111.23 (4.91)	10.97	0.74 (0.91)	1.37 (2.00)
	Female	11	109.58 (5.02)	16.64	0.23 (0.66)	0.81 (1.28)
	Total	16	110.10 (3.69)	14.75	0.20 (0.55)	0.91 (1.09)

The main effect of time yielded an F ratio of $F(1,14) = 0.090$, $p > 0.05$ indicating the effect of time was non-significant for the baseline, (M = 111.32, SE 4.96) and follow_up, (M = 110.41, SE 4.11). The main effect for gender yielded an $F(1,14) = 0.004$, $p > 0.05$ indicating the effect of gender was non-significant for male (M = 111.12, SE 7.12) and female (M = 110.61, SE = 4.80). The effect of the interaction between time and gender was also non-significant, yielding an F ratio of $F(1,14) = 0.143$, $p > 0.05$. Given the results were non-significant for all levels of both factors, the null hypotheses were retained. A plot of cumulative attitude scores versus time indicated an interaction existed, though not significant, and is presented in Figure 5.

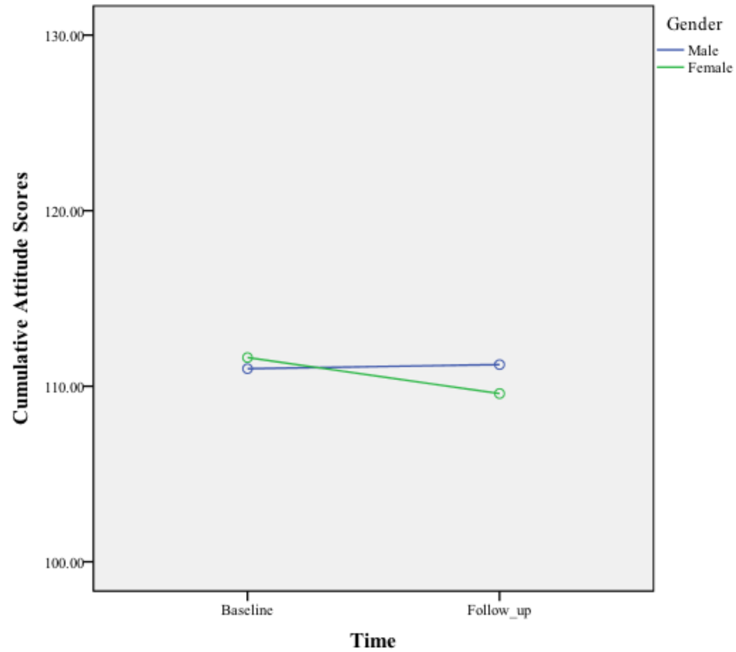

Figure 5. Cumulative attitude scores versus time for male and female students

Qualitative Data

Collection. Prior to conducting qualitative research in the Duck Valley Community, I reviewed guidelines for conducting research in a Native American community. Though I am a member of a Federally recognized tribe, I was not a member of the Shoshone-Paiute tribes, and therefore I recognized and understood that I was entering a tribal community as a guest. As a guest, it was important for me to establish the appropriate relationship and demonstrate respect toward the community I was about to enter. Developing "Respect" and "Authentic Relationships" with tribal communities are two of the Guiding Principles for Engaging in Research With Native American Communities (Straits et al., 2012, p. 6 & 8). Respecting and honoring the tribal sovereignty and requesting their permission to conduct research within the community were imperative in the research process. In addition, the relationship must be sincere, built on mutual trust and be an equal partnership and collaborative effort (Straits et al., 2012).

In order to establish a trusting and respectful relationship, I coordinated with one of my committee members, Dr. Ed Galindo (Yaqui), to help establish communications with the Owyhee Combined School administration. Dr. Galindo had already established a relationship with the Duck Valley community during previous educational activities and was instrumental in establishing contact between the Principal of the Owyhee Combined School, Mr. Joe Mirich, and me. In addition, formal letters of introduction and permission were sent to the Chairman of the Shoshone-Paiute Tribes as well as Mr. Mirich.

In response to the introduction and permission letters, I was invited to visit the Duck Valley community during the month of December 2013. Dr. Galindo accompanied me to the Owyhee Combined School during the week of December 9th, 2013, not in the capacity of a committee member, rather, in the capacity of an Elder presenting a family member to a new community. Upon arrival in Owyhee, the temperature was in the low single digits with clear skies and calm winds. Dr. Galindo and I met the Owyhee Combined Schools principal, Joe Mirich, who provided me with a list of the students that were available to interview, two less than the original number requested. Two students who participated in the original summer program had since moved out of the area. I then met with David Baker, the Owyhee Combined School's coordinator for the Gaining Early Awareness and Readiness for Undergraduate Programs (GEARUP). David provided me with a list of students and a schedule for interviews beginning at 0745 on Tuesday the 10th of December and continuing each day until Friday at noon.

On December 9, 2013, I conducted a presentation for the student body of the Owyhee Combined School from K – 12th grade at 1:00 pm. Approximately 200 students participated in the assembly. I provided an overview of my journey to the astronaut corps, with particular emphasis on my college education and lack of motivation. I stressed the importance of finding a direction in life and relying on family and mentors to help guide your journey. Unfortunately, the visuals in the presentation were not visible due to high ambient lighting from the snow-covered mountains outside the gymnasium to the east. Even though, the students were incredibly respectful and attentive during the presentation.

During the evening, I was invited to a community dinner where I met with community leaders, parents, and students (50 in attendance). I thanked my hosts and explained the purpose behind my research and the purpose of my visit to Duck Valley. I also shared that it was important for me to establish a shared relationship that demonstrated my honor and respect for their community. Following the community dinner, I conducted a one-hour presentation in the Owyhee Combined School gymnasium for all community residents that desired to attend. I presented a slide show documenting my background in which I discussed the challenges I experienced in my education and how mentors and motivation played a key role in my success. There were 70 people in attendance from the community. The temperature outside was eight degrees Fahrenheit.

A total of 21 students participated in the 2010 IMU SOI program. Four students that participated in the program were not available to be interviewed. One student was out sick the entire week and the other three students had moved from the local area and no longer attended the Owyhee Combined School. Table 4 provides a list of the participants interviewed during the case study.

Table 4

Participants in the Case Study

Name	Gender	Grade
Steve	Male	8th
Denise	Female	11th
Kate	Female	8th
Skyler	Female	8th
Andy	Male	10th
Bob	Male	9th
Hope	Female	8th
Abby	Female	8th
Rose	Female	10th
Heidi	Female	10th
Ajay	Male	9th
Stacey	Female	10th
Robert	Male	9th
Thomas	Male	8th
Carmen	Female	11th
Nicky	Female	10th
Becky	Female	8th

Interviews began on the morning of Tuesday, the 10th of December 2013. Five interviews were conducted on Tuesday, six interviews were conducted on Wednesday, four interviews on Thursday, and one interview on Friday. Interviews ran approximately 30 minutes to one hour in length. An additional interview was conducted over the phone in May due to the student's absence during the initial interview period. Participants were dismissed from their respective classes in order to attend each interview. Two interviews were conducted in the Principal's office, 14 interviews were conducted in the Vice-Principal's office, and one interview was conducted over the phone. All but two of the interviews were captured using a small electronic recorder. Two students requested I document the interview through hand-written notes.

Following the completion of the interviews, the recordings were transcribed using ExpressScribe software and a narrative of each transcription was written. I returned to Owyhee on the 16th of March and met with 14 participants to conduct member checks on the narratives written based on each interview. Fourteen narratives were provided to their respective participant and thirteen participants provided positive feedback. Three students requested small changes to their respective narratives. In one case, a female student asked me to add an additional comment regarding her participation in home construction with her father rather than merely observing it. Two participants requested their pseudonyms be changed. The remaining participants that reviewed their respective narratives were pleased with the result and did not request any changes. One participant was not in attendance the day the member checks were being conducted, but provided feedback through the Principal on Wednesday, May 14, 2014. Two narratives for the hand-written interviews had not been completed at that time of the initial member checks and were subsequently provided to the Principal for distribution to the remaining two students on May 14th, 2014. Member checks for the remaining two narratives were conducted and feedback was provided to me through the Principal on May 16, 2014.

Narratives. The narratives for each student are provided in the following sections. Each narrative contained the following subsections: Family, Motivation and Collaboration in Education, Recollections of the NASA SOI program, Native Americans in the Curriculum, and Long-term goals. Each subsection was developed to capture the key themes that emerged from the interviews. Even though 25 specific questions were asked during the interview, some of the answers provided by the participants required follow-up, clarifying questions.

Steve. Steve was a quiet young man who was in the eighth grade and volunteered for the SOI program as a fifth grader. Throughout the interview, Steve was relatively withdrawn and often did not answer "verbally" in response to some of the questions. Though quiet during most of the interview, Steve did respond to all of the questions, either non-verbally or through short, concise answers. He never appeared disinterested in the conversation or uncomfortable with the type of questions asked.

Family. Though it was not determined whether Steve lived with both of his parents, Steve stated that his parents did encourage him to go to college. In response to my inquiry about his parents' academic background, Steve said his father had attended some college, but did not graduate. Steve did not elaborate on his mother's educational background, but he did state that she was the one who required him to attend school. In a separate discussion with the school principal, he explained Steve's mother was often engaged at the school and was known to be a strong advocate for her children's education. Steve had one sister who was older and, he believes, will attend college one day, though he did not discuss why he felt that way. Steve did not express any close relationships with extended family members who are influential in motivating him toward a college education. Steve described the parental involvement in his education was limited to telling him to do his homework and did not include assistance with his assignments or coursework. When asked if his family ever used examples to help with his homework, he stated, "No, because they don't really know how do it."

Motivation and collaboration in education. Steve was a student who viewed education as a chore and only something to be done because his family, specifically his mother, required it. When asked if he liked school, his response was glum, “Uh, don’t really like it.” When he was asked to elaborate on what he didn’t like about school, Steve stated it was because he didn’t like doing the work. If given the opportunity, Steve would chose to stay home rather than attend classes. While at home, Steve stated that his preference would be to sleep or watch television. Like many of the students I interviewed, Steve was interested in technology. He indicated that the use of technology, specifically computer use in the classroom, would be something that would make school more engaging. He also commented that learning, specifically science was more fun because he was able to use his hands in the process. When asked to elaborate on the use of his hands in the classroom, Steve said he felt more “active,” rather than just sitting in the classroom listening to the teacher.

In contrast to his expressed lack of interest in school, he demonstrated an understanding of the necessity to attend classes, because he recognized if he didn’t graduate he would look back on his life and think, “I haven’t done anything with my life.” When asked what a college degree would mean to him, he stated that it would mean, “that I accomplished something.” Even though he understood the importance of a college education in his life, he did not express a desire about what he would study, or where he might attend college.

Recollections of the NASA SOI program. Given that one of the goals of the IMU NASA SOI was to increase the interest of students in science and mathematics, it was important to ascertain whether the students who participated actually experienced an increase in their level of interest. As with every other student interviewed, Steve remembered the

NASA Summer Program in 2010. When asked to identify particular details about the program, Steve, as did every other interviewee, was able to identify at least one activity that was accomplished during the summer program. When asked if there was a particular thing he recalled about the program, Steve stated that he remembered building a pyramid out of spaghetti and gumballs. When asked why he remembered that particular activity, Steve stated, "I like working with my hands.” When he was asked if he normally did hands-on activities at school, Steve shook his head no, but stated that it would be easier to learn in class if he was able to do more hands-on activities. Steve was asked if his participation in the summer program changed the way he felt about mathematics or science and he was quick to answer that it increased his interest in science. When asked if the reason he enjoyed the science was because he was able to use his hands during the activities, he replied that it did.

Given his disinterest in school, it was important to determine the factors that enabled Steve to be at school on a daily basis and what kept him occupied and engaged in the classroom. When asked what motivated him to come to school, Steve stated, “Cause my mom tells me to.”. When he was asked if his mom didn't make him come to school what he would do, Steve replied, "then I would stay home.”. Steve stated that he was not particularly interested in school, not because he did not understand it, but because he just didn't want to do the work. When asked what he would rather do, he stated, "I dunno, stay at home.” When asked what he would do if he stayed home, Steve replied he would "watch TV.” When asked if he learned anything from watching the TV he replied, "sometimes.”. In order to determine if Steve had any long-term goals, he was asked what would happen if he continued to stay home and watch TV for the next 10 years, Steve replied, "I'd be the same.’. He continued to state that he would be in worse shape if he stayed home rather than go to school and he understood that by staying home and not continuing his education, his life would be worse off, "because I haven't done anything with my life." When he was asked what would motivate him to come to school he replied, "If it was more fun." I inquired whether or not more hands-on activities in school would make it more fun and Steve answered in the affirmative. I asked if hands-on activities would also increase his interest in mathematics and he quickly replied that he did not like math. Steve went on to say that the only way he would have fun at math was if, "I didn't do it."

Though Steve had stated he did not like coming to school, when asked whether he liked math or science, he claimed that he liked coming to school to learn about science. His most recent recollection of science class was a previous Earth science course. Though he could not identify a particular thing about his Earth science course that interested him, he stated that the NASA summer program did make science more fun. When asked if it was because of the hands-on learning activities he stated, "Uh huh."

Given that Steve had stated he was not interested in coming to school, he was asked if a monetary incentive would motivate him to come to school. I asked him if the offer of 10 dollars would make him try hard to get in an A and he responded, "No, because it's only 10 bucks." In order to determine the amount that would make it likely he would attend school, I asked him what he needed as a monetary incentive and he stated, "a new phone." He also made it clear that he believed he would have to get an "A" for the entire semester, not just for one assignment, in order to receive the phone. I asked him if he would return the next year and continue getting an "A" once he received the phone and he replied that he would not. His requirement to come to school the following year was for a larger monetary incentive, a car. It was clear that Steve was motivated by external factors and not for intrinsic reasons, regardless of whether it was to come to school or achieving a particular grade in the classroom.

I was interested in determining whether or not the students found collaborative learning as an essential part of their education. Each student valued collaborative learning, but for a variety of reasons. Steve indicated that he valued learning with others as a way to accomplish homework. Not by working collaboratively to arrive at an answer, rather, to make the homework easier by being able to copy from his friends. When he was asked if he learned anything by copying other students' homework, he replied, "No." Delving deeper into the notion of copying as a learning strategy, Steve clarified that it would be helpful to him if his friends showed him the process and worked him through the problem. He thought this was an easier way to learn things that he found difficult, specifically mathematics. When he was asked if learning with others was helpful for subjects that he did not find difficult, he stated that he would rather do the work himself because the others around him worked more slowly.

It was also interesting to learn that Steve did not feel intimidated if his friends made fun of him for being smarter in a particular subject. He did not see it as a form of bullying; rather, he would make fun of them in return. He stated that he did not make fun of people he felt were smarter than he was in a given subject. Steve was not someone who was likely to act in a manner that indicated he was less intelligent in a subject than he really was. He appeared to be someone who was confident in his place in the classroom and not intimidated by others.

Native Americans in the curriculum. In order to determine if Steve understood what a scientist was and whether or not he saw Native Americans in the roles of scientists or mathematicians, he was asked to describe his impression of a scientist. He answered, someone with a "lab coat" and "glasses, short hair, khakis, and shoes." When asked if he had ever seen a scientist who was a woman, a Native person, or other minority, Steve stated that he'd seen a woman scientist but not a Native American or an African-American. It was interesting to note that Steve, as well as every other interviewees, was not familiar with any examples of Native Americans as natural scientists or engineers nor did his teachers provide examples in class.

Long-terms goals. Steve was a young man that did not look far into the future to determine where he would be in the years following high school. He did not have any long-term goals that applied to education or the work force. When asked where he saw himself 10 years in the future, he was not able to provide an answer, even with repeated prompting or a request to "use your imagination."

Denise. Denise was a young woman in the 11th grade who had a definite plan beyond her high school education. She was very articulate in the interview and provided answers that were well thought out and clear. She displayed a passion for science and an interest in taking advanced placement courses in an effort to be fully prepared to take STEM-related courses in college. Her desire was to attend a local college with the intention of receiving an associate degree in biology, eventually leading to pre-med, medical school, and a career as a surgeon. Though Denise was interested in the medical profession as a career, she also displayed an interest in music and stated that her favorite class in school was band.

Family. Denise was a member of a large family that had a history of post-secondary education. Her mother had been pursuing a PhD in Education and her father was retired. She stated that her father did not attend college, but she saw him use math as a part of the work he did in constructing an addition to their house. She had numerous sisters, both younger and older. Her older sisters had all attended college and at least one worked in the medical field. She stated that her sisters provided encouragement and insight into the challenges of a college education and that her mother emphasized that she should concentrate on taking advanced placement courses in high school in preparation for the demands of a pre-med major. When we discussed the importance of obtaining a college education, she stated that her desire to go to college was to “support my family and to support myself. And make sure I have a good future.” It was interesting to learn that she referred to her classmates as family and that working with others in school was a natural part of her educational experience.

Motivation and collaboration in education. Denise was clearly motivated to learn for intrinsic reasons. Her desire to do well in school was based in part that obtaining good grades made her feel good and prepared her for pre-med course work. “…if I get a good grade, then its going to be, like, be good for college.” Denise viewed her education as a path to a successful career and prosperous future, both for herself and her family. Though she stated that she really didn’t enjoy coming to school, except that she could attend with her friends, she claimed her interest in school was based on her enjoyment of learning different things and she saw that excelling in her high school education boded well for her ability to do well in college. Her interests in school were varied, from science to music, but she stated that mathematics created some anxiety for her; that is, the fear of doing poorly and getting a low grade, “especially if it is the last test of the year.”

When asked what type of teaching method she would like a teacher to employ, she stated that she preferred her teachers to interact more with the students, “Someone who interacts…talks about the subject more.” Referring back to the summer program, Denise enjoyed the hands-on experience that was core to the program and she wished that she had more practical examples in class and the opportunity to conduct more hands-on activities. She was interested in having as much interaction with her teachers as possible and being engaged in the learning process.

When I inquired if she saw math and science as relevant in her everyday life, Denise was able to visualize the use of math by witnessing and helping her father use math during construction work on their home. She also related that science was involved in the care of her horses. She did not elaborate on the specifics of the scientific methods employed, but she did recognize that science was important in the care and feeding of her animals. When asked if she enjoyed collaborating with her friends as a part of her educational experience, Denise stated that when a particular subject or problem was difficult, it helped to work with others. Otherwise, she enjoyed working alone because she felt it was easier to learn by herself. With respect to competition in the classroom, Denise described how her math class utilized computer programs in which the students would compete against each other to get the best score. She didn't view the competition in a negative way, but something where everyone benefited and that it was meant to "make sure everybody understands it."

Recollections of the NASA SOI program. As with the other students who were interviewed, Denise was able to recall at least one of the activities that occurred during the summer program three years earlier. At the time, Denise was in the 8th grade and had the opportunity to attend a launch of the space shuttle at the Kennedy Space Center in Florida the following year. She was able to immediately recall that she built and launched rockets during the summer program. She enjoyed using her hands to build the rockets and she stated that school would be more enjoyable if she had the opportunity to do the same in science class. When she was asked how she was taught science in the classroom, she stated, "We do worksheets and she tries to interact with us." She also recalled that one of the summer program instructors, Dr. Aaron Thomas, offered classes at the University of Idaho for students during the summer. She did not discuss whether or not she attended those classes in the following years, but she did state that her interest in science was increased due to the summer program, and she was taking different science courses now than she would have otherwise.

Native Americans in the curriculum. Like all of the other students interviewed, Denise was not able to recall any instance where examples of Native Americans as natural scientists or engineers were discussed as a part of the curriculum.

Long-term goals. . Denise had set her sights on the goal of becoming a surgeon. She was diligently working toward that goal by taking the appropriate course work in high school to ensure she was prepared to enter college and be successful in her academics. She had positive role models in her family who have enabled her to view herself as a successful medical professional. She understood the challenges of college based on conversations with her mother and siblings and was taking the steps necessary to achieve that goal.

Kate. Kate was a young woman in 8^{th} grade with aspirations of becoming a pediatrician as an adult. Kate was engaging in the interview, providing detailed answers as she needed to, but often kept her answers short and to the point. Though her family's education level did not extend beyond high school, she had set her sights toward a medical career at an early age.

Family. Kate's long-term desire to become a pediatrician may stem from the encouragement she received from her parents on the importance of a college education. Neither of her parents completed college, though her father did take some college course. Her mother did not finish high school or complete the GED. When asked why her mother did not complete the GED, Kate said, “She tried for a little bit, bit it was too complicated for her.” Kate’s father was a local merchant, but had plans to become a police officer. Kate did not elaborate on her mother’s line of work.

Motivation and collaboration in education. Kate was not particularly interested in school except when she had the opportunity to learn “fun things” and spend time with her friends. When asked to explain what she meant by “fun things”, Kate was not specific, other than to say, “I don’t know. New stuff, I guess.” She explained that her favorite classes consisted of reading and geography, specifically mentioning reading the book, Riding Freedom, a story about an orphan girl and a horse that she finds after running away from the orphanage. When asked what made science, specifically Earth science, interesting for her, she replied, “ How rocks and everything form.” Continuing with the theme of Earth science, I asked her if any of the lessons in class dealt with the geology in her local community. For example, did they ever talk about volcanoes and lava flows? She replied that they discussed these topics on occasion, and that it made the class more interesting. When asked if she was more interested in learning about something that was a 1000 miles away or learning about something because it was close to home, she indicated that closer to home was better.

Kate’s interest in math was slightly greater than her interest in science. With respect to mathematics, Kate explained that she had difficulty with algebra, but was fortunate to have a teacher that used practical examples when teaching mathematics. When I asked if she had ever measured something, she explained that she liked to cook and discussed the use of measuring cups and changing amounts within the recipe, depending on the serving size of what she was preparing to cook.

Kate's motivation to study came from both internal and external factors. Kate commented that her motivation to get up in the morning was so she could, "Go to school so I could get a good job, have money when I'm older." She was likely to be motivated by the feeling of getting a good grade, as she was with the possibility of getting a monetary gift. She answered that she would continue to try and get good grades even if the possibility of receiving money was taken away.

Kate had commented that she looked forward going to school because she had the opportunity to see her friends. With respect to her friendship and collaborative learning, Kate commented that she enjoyed learning with her friends when the subject matter was difficult. She answered positively when asked if learning was easier with a group of friends when they could share and collaborate regarding the problem and solution.

Recollections of the NASA SOI program. Kate volunteered for the summer program when she was in the 5th grade. Like many of her peers, she recalled the rocket building as an enjoyable activity. When asked why, she commented on the fact that she was able to "make stuff." She also commented that the students were given notebooks to use as a journal for their activities. Kate commented that the students built their rockets as a group and that the students competed with each other on how far their rockets would fly. In addition, Kate described how she conducted an experiment by dropping eggs from the football bleachers, after having built protective shields around them. She described her egg as being protected by duct tape and bubble wrap, which properly shielded her egg from breaking. Kate indicated that she enjoyed the combination of a hands-on and collaborative activity during the summer program.

Kate answered positively when asked if she would enjoy doing more activities in class that were hands-on. When asked if the summer program changed her opinion about mathematics and science, compared to her level of interest in both subjects prior to the program, she stated, “a little bit,” but clarified that her interest in science “was better” at the completion of the program.

Native Americans in the curriculum. Like her peers, Kate could not provide an instance where she could recall when teachers used examples of Native Americans as natural scientist or engineers.

Long-term goals. . Kate was not specific when asked about her long-term goals, except to say that she would probably still be in college 10 years from the time of the interview.

Skyler. Skyler was a young woman in the 9th grade who displayed a penchant for music and performing. She aspired to attend the Julliard School of Music in New York City and pursue a career as a singer. She was very forthcoming in her interview and provided detailed and enthusiastic answers. Skyler was fortunate to have many members of her family, both close and extended, who graduated from post-secondary education, which motivated her to attend college at some point in her life. Though she did not express a particular interest in math or science, she did indicate that she enjoyed learning science when it pertained to things in her everyday life. She related that her experience in the NASA summer program was fun and increased her interest in science because she was able to make things as part of the program activities. Her primary motivation with respect to learning was that she enjoyed, “Doing fun things.”

Family. Skyler's parents graduated from tribal colleges and her grandparents are graduates of a state university. She was unsure of the degrees her parents obtained, but she stated, "I just know they made it through." Skyler was unsure of her grandparents' degrees, but she stated that her grandparents were the ones most likely to discuss with her the importance of attending college. In addition to her parents and grandparents, Skyler also stated that all of her aunties and uncles had graduated from college. Perhaps because her family had a remarkable record of post-secondary education, Skyler was clear regarding her intention to attend college and pursue a higher education.

Motivation and collaboration in education. Skyler's primary motivations for coming to school were the good feelings she received from being with her friends and the opportunity to do poetry "out loud." When she was asked what motivated her to learn, she responded that it was "Mostly just so I can know something. So people don't look at me as dumb." Asked whether it was a "personal thing," she replied, "Yeah, just so I can feel good." Though she indicated she was a bit shy, the opportunity to read her poetry aloud gave her a feeling of self-confidence and personal satisfaction. With respect to STEM subject matter, Skyler indicated that she had always been interested in science; beginning from an early childhood interest where she thought science was about "mixing stuff together." She admitted that mathematics was not her strong suit. In her mathematics class, she enjoyed the fact that her teacher used examples relevant to her everyday world. She cited one instance where the teacher used free throw shots in basketball as an example and related the outcome to percentages. She stated that it was easier for her to understand the subject matter when the instructor used real world examples that she could relate to. Her math teacher also used a "Smartboard" in class that the students were sometimes required to demonstrate problems in front of the class. Skyler did mention that there had been many visitors to her school to speak to the students about their professions. She recalled that one of these visitors was a scientist, though she did not know for sure and could not recall what type of scientist the visitor was.

Skyler's interest in education extended beyond her high school years and she had every intention of attending college. Her interest in music was her primary motivator, but she admitted that she should "go to college for math… too." She followed that admission with the comment that she did not want to go to a college where, "I'm just bored the whole time. I want to do something I love to do." With respect to collaborative learning, Skyler commented that she enjoyed the opportunity to learn with her friends, specifically in math and science. Collaborating with her friends allowed her to work through problems and be assisted with difficult concepts. She specifically mentioned working with her friends in diagraming the structure of atoms and working with "solutes, solvents, stuff like that."

Recollections of the NASA SOI program. Skyler volunteered for the summer program when she was in the 6th grade. Like many of her peers, she recalled the rocket building as the most memorable activity. When asked why, she commented on the fact that she was able to build it by hand as well as personalize her construction. "…We got to name our rockets, too. Decorate them and stuff." She built her rocket individually, but commented on the fact that she competed against her classmates in the rocket launches. She stated that she enjoyed the activity because it was fun and that she was able to do something with her creation. Skyler answered positively when asked if she would enjoy doing more activities in class that were hands-on. When asked if the summer program increased her interest in math and science she stated, "In science, definitely." Unlike the rest of her peers, Skyler recalled, in detail, the making of a robotic hand. She explained how they made a cardboard cutout of a hand and attached strings to straws for manipulating each finger. Skyler responded in the positive when asked if she enjoyed tinkering, taking stuff apart, and putting it back together. Her detailed explanation of the activities she accomplished during the summer program was indicative of her enthusiasm for experiential learning and acknowledged enjoyment of working with her hands.

Native Americans in the curriculum. Skyler could not recall any instances in her studies where the teachers shared examples of Native Americans as natural scientist or engineers. She did recall hearing about and seeing examples of Native American pictographs and petroglyphs drawn by Native Americans. She stated that her grandparents were responsible for sharing this information with her.

Long-term goals. . Skyler had a clear understanding that she will attend college one day. She had a passion for singing and aspired to be a performer someday. In addition, she recognized that her education should be well rounded to include mathematics and science, not just the arts. Her close and extended family set a very high bar for scholastic achievement and they encouraged her to pursue higher education.

Andy. Andy was a young man in the 10^{th} grade who had the desire to attain a college education in chemical engineering and return to his hometown to pursue a career in farming or ranching. He stated the reason for choosing this type of career path was because, “Some of my family does it… and I’m good at it.” Andy was a compelling interview who was quick to answer my questions and thorough in his responses. He clearly had a strong work ethic and was not one to do less than he was capable of completing. His responses indicated that he had a strong connection to his family and that he valued the opportunity to remain a part of the community, after achieving a bachelor’s degree.

Family. Andy indicated his parents were the ones that encouraged him to attend college. His mother was a college graduate who attended two universities. Andy was not able to recall type of degrees she attained, but he stated that his mother worked in education. Like many of the students interviewed, Andy identified his mother as the family member that was most responsible for encouraging him to attain a college education. He also pointed out that his mother conducted experiments at home to demonstrate science concepts. According to Andy, in order to motivate him, his mother would tell him he "couldn't live on the couch all his life." According to Andy, his father attended college, but could not recall if his father graduated. He stated his father worked on the family's ranch in the local community. Andy said that his grandparents expressed an interest in how he performed in school, though he did not know if either of his grandparents attended college. Andy had a sibling that also attended the NASA summer program.

Motivation and collaboration in education. Andy understood the importance of completing his high school education and continuing through college, perhaps because his mother was an educator and because he enjoyed the opportunity to learn new things. When asked to differentiate between learning during the school year and learning during the summer program, Andy pointed out that "school is more of the learning part… and then you go to the summer things and those are the fun part where you still learn." Andy stated that his motivation in education stemmed from a natural curiosity to learn new things and the feeling of accomplish he received in the process, not from an external reward. He enjoyed both mathematics and science and he even commented that he wished his geometry class were a bit more difficult. His interest in science extended to chemistry where he enjoyed the opportunity to learn about chemical reactions and even spent time during his summer vacation attending a chemistry class at a state university.

Andy found enjoyment working with his fellow students often in the role of a tutor, helping them earn grades that allowed them to remain in the school sports programs. He did not experience any negative reactions from his friends regarding his abilities in math or science. He maintained a low-key attitude and did not flaunt his competence. When asked how he works with others to collaborate on assignments, Andy indicated that he repeats the instructions that were provided by his teacher and explains the steps in details, utilizing examples to reinforce the concept.

Andy understood the importance of a college education because it could provide him with the opportunity to improve his quality of life by expanding his knowledge of the world around him, increasing his earning potential, and sense of independence.

Recollections of the NASA SOI program. Andy recalled building and launching rockets as well as building and testing the egg drop activity. When asked why these activities stood out in his mind, Andy replied that they were fun to do and required him to use his hands in the process of learning. Andy stated that he worked with his friends during the activities, but also competed against his classmates. He made it clear that he enjoyed the competition and when he was asked if he enjoyed winning he said, “I love to! Who doesn’t?” When Andy was asked to compare his experience in the summer program with his normal class routine, he was definitive in his belief that learning in the experiential environment of the summer program was what he wished he did on a daily basis in school. It was interesting to note that Andy’s day during the summer program was preceded by three hours of work on a ranch, prior to coming to school. Following the completion of the day in the summer program, Andy returned to work in the field until the sun went down. Given how long his day was, including both the time at the summer program as well as his work on the ranch, Andy still found the summer program to be fun and enjoyable.

When he was asked to describe whether or not he found the program and the things he learned to be useful and representative of his everyday life, Andy remarked, “There’s always something there that you need to know.” He also remarked that he liked working with his hands and whatever he learned in college he wanted to bring it back and use it on the farm.

Native Americans in the curriculum. Like every one of his peers that were interviewed in the case study, Andy could not recall one instance where his teachers provided him examples of Native Americans as natural scientists or engineers. When asked if he would enjoy the opportunity to meet Native Americans who are professionals in the STEM fields and hear them talk about their experiences and education, Andy said, “Yeah, that would be cool. I like talks like that.”

Long-term goals. . Andy’s goal was to complete an education in chemical engineering and bring what he learned back to the reservation to be a successful rancher. He was clearly interested in learning as much as he could. He understood he could use the experience he had living and working on a ranch and use his education to improve the quality of life of his community.

Bob. Bob considered himself an average teenager: listening to music, watching TV, using Facebook, and watching YouTube videos. He participated in school sports activities, primarily track and field, but he had been a member of the school’s football and basketball teams. He was in the 9th grade and participated in the NASA Summer program as a 6th grader.

Bob was engaged during the interview and provided clear and concise responses to the questions he was asked. Bob came across as a respectful young man with focus and someone who appreciated order in the classroom as a prerequisite to an effective learning environment.

Family. Bob's mother stressed the importance of having a good education and encouraged him to attend college. Bob could not remember whether his mother earned a college degree, but he did indicate she worked in the education field. Bob had a sister who attended college through online courses, but he did not know her field of study. Bob indicated that his sister did not share with him any insights into how difficult college was, since she was very busy with her studies and probably did not have the time to sit down and share her feelings. When asked if his mother encouraged him to enter college to study a particular subject, he stated that was a decision she left up to him to make. Bob did not discuss any additional close or extended family members and whether or not they played any role in his current and future educational efforts.

Motivation and collaboration in education. Bob enjoyed being able to come to school, but he remarked he did not like some of his teachers. When asked why he didn't like certain teachers, Bob explained that some of the teachers did not control their classroom and allowed some of the kids to "run wild." He commented he felt teachers should have some level of control, but only be strict "to a certain point." He enjoyed one particular teacher because he felt he was somewhat laid-back, but still retained control of his class. This was a teacher that Bob hoped to have for future courses because he felt he had a good rapport with him.

When he was asked whether he enjoyed learning using hands-on activities or a more passive form of learning, such as reading from a book, Bob stated that he favored a combination of both. Bob indicated that he liked solving problems, particularly in algebra or drawing diagrams in science, to explain different stages of development. When it came to collaborating with his classmates, Bob enjoyed helping his friends when they asked for his help, but he preferred working on his own. He seemed a bit jaded because he felt his friends were more interested in Bob doing the problems for them; rather than helping them solve the problems as part of the learning process. Bob commented that he did not avoid helping them when asked, because, as he said, "I'm a polite person so, I really can't say no." Bob was asked if any of his classmates made fun of those who demonstrated a high degree of confidence with a particular subject. He was quick to remark that many of the students had put bullying behind them the previous year and he didn't see that as an issue in his current school year.

Recollections of the NASA SOI program. Bob was the first interviewee to recall building an irrigation system out of straws, but also recalled the other activities as well. When asked if he worked with others during these activities, Bob remarked that he did at times, but preferred working on the projects alone, if possible. He stated, "I'm one of those types… try to stick to myself." Bob commented that the part of the program he enjoyed the most was meeting the NASA workers who administered the program and thought "they were good people."

When asked if he thought his participation in the NASA summer program increased his interest in math or science, Bob commented that he was more interested in space and astronomy than before the program. When asked to clarify why space and astronomy were subjects that he found interesting, he shared that he has always had an interest in space, wondering, "…what's out there? How does everything work in the universe?"

Native Americans in the curriculum. Bob could not recall any instances where his teachers discussed the role of Native Americans as natural scientist or engineers. Like his peers who attended the summer program, he would like the opportunity to hear more about his ancestors and examples of how they used their knowledge to observe the world around them and build structures that increased their ability to survive in a very hostile environment without knowledge of western science, mathematics, or engineering.

Long-term goals. . Bob was interested in one day becoming a psychologist and returning to his community to help others. When asked if he saw himself attending college one day, Bob said, "Definitely!" He saw a tremendous amount of value in being able to help others in his community and participate in organizing health care facilities that he felt his community currently lacks.

Hope. Hope was a young woman in the 8th grade. She attended the NASA Summer Program during her 5th grade year. Even though she was only in 8th grade, Hope already aspired to study veterinary medicine at a university in the Midwest. She had older siblings that had attended and graduated from college, which may have formed the foundation for her desire to attend a post-secondary institution. She was animated during our interview and answered the questions thoroughly and thoughtfully. Like many of her peers in the NASA Summer Program, her interest in science increased due in part to the experiential, hands-on nature of the activities in which she participated.

Family. Hope's mother played an instrumental role in encouraging Hope to attend college one day. Her mother was a college graduate and worked in education. Hope commented that her mother was “really big on science” such that she would perform science experiments at home in order to increase her children’s interest in the subject. Hope did not discuss her father’s education or his role in motivating her to attend college. Hope had older siblings that had attended and graduated from college as well as graduate school. When asked if they shared with her their college experiences, Hope said that her sister had told her that college took a lot of hard work. She did not discuss whether or not her brother had shared his insights regarding the demands of college. Hope’s extended family members were not involved in encouraging her to attend college, only her immediate family members provided her with guidance regarding continuing her education beyond high school.

Motivation and collaboration in education. Hope expressed a reasonable desire to come to school, but it was not something that she looked forward to on a daily basis. She stated that she enjoyed it more when substitute teachers taught the class. When asked if she enjoyed the change of pace that a substitute teacher brings to the classroom she said yes, but she felt she still learned something in the process, even though the class seemed easier with a substitute. When asked whether she enjoyed learning from a book or participating hands-on in the learning process, Hope commented that she preferred being able to learn in science class using hands-on methods by “getting her hands dirty.” When Hope was questioned about her motivation to learn, she commented that her desire to learn was based on an internal feeling. Her motivation was not tied to an external reward or monetary compensation. She was clear that her motivation to learn, in all of her courses, was intrinsically based.

Hope’s was more interested in science than mathematics, because she often found math confusing. “I’m not a huge fan of it [math].” She stated that she couldn’t visualize what the math represented. However, when asked if she could describe an instance when she saw math being used in her everyday life, she said she could definitely see math everywhere. For example, she was able to relate it to basic mathematical concepts used when purchasing items in a store. Her interest in science stemmed from a natural curiosity about the world around her and she said, “Everything, how everything works… how things form.” In referencing some photos taken by the Hubble Space Telescope, she was asked if she ever questioned how far away things were in the universe, she said, “Yeah, I always do.”

Hope was asked if she collaborated with her friends in the learning process and she said it depended on the subject and how difficult it was. The more difficult the subject, she used math as an example, Hope preferred to work with others in order to understand the process. Hope also commented on the fact that working with others allowed her to compare answers to determine if she has completed the problem properly. When asked what she would do, in a collaborative setting, if her answers differed from her classmates, she said, “You can break it down…each step they did to get the answer.” Hope stated that collaborating with friends was not necessary in science class, because she felt the subject was not that difficult. Hope was also asked to explain if there were times when she felt anxious about a particular subject, and she stated that she often felt that way before a big math test. When asked to describe how she would overcome that feeling, she commented that the best way was to take really good notes to be properly prepared.

Recollections of the NASA SOI program. Hope was able to recall some of the activities she participated in during the summer program. She recalled the egg drop activity and how she constructed the container to prevent her egg from breaking using tissue paper. When I asked her if she understood the practical application of the egg drop activity she said, “I think it was the Mars Rover.” Hope was also able to recall the rocketry activity and how they used air pumps to launch the rockets. Hope commented that she built her rocket on her own and they measured the distance that each rocket traveled after it was launched. When I asked her if the program help increase her interest in math and science, she replied that she has always been interested in science, but she really enjoyed the astronomy portion of the program. When I asked her if they used telescopes during a night activity, she could not remember, but she did recall having a star party the following school year in one of her science classes.

Native Americans in the curriculum. When Hope was asked if her teachers ever provided examples of Native Americans as natural scientists and engineers, she stated that it was not really something she could recall. Her response was similar to her peers that participated in the summer program. Hope commented that it would be "cool" if her teachers did provide examples in the curriculum.

Long-term goals. . Hope had aspirations to attend college one day and study veterinary medicine. Even though she was in 8th grade, she was already formulating a plan for her future. Perhaps this was due to the influence provided by her mother and siblings regarding the educational process and due to the fact that she had role models within her family that she could identify with and emulate.

Abby. Abby was an 8th grader who participated in the NASA Summer program when she was in 5th grade. She aspired to be the first person in her family to complete a college education. She had a very large immediate family in which some of her siblings had attended college, but none had completed their college education. She desired to be a geologist as a professional and looked to attend a college on the east coast. Abby was relatively quiet during our interview and her responses to the questions were concise and thoughtful.

Family. Abby hailed from a very large immediate family. A few of her siblings had attempted college, but none had completed their coursework and did not graduate. Abby commented that some of her siblings did not complete high school. She went on to say that all of her siblings still resided in the local community. Abby hoped to be the first one to attend and complete her college education. When she was asked if any of her siblings shared their experience or offered her words of encouragement regarding the challenges associated with college, she said that they thought she would be able to accomplish it, because she had good grades. Her mother was taking online college courses with the intention of completing a degree in criminal justice. Abby stated that her father did not attend college and worked in the local community supporting tribal infrastructure. Abby did not disclose whether or not she had any extended family and their educational backgrounds. When she was asked to explain why she thought she should go to college, Abby commented that she would have a "good life."

Motivation and collaboration in education. Abby commented that she liked coming to school because she had the opportunity to "learn something new everyday." Her primary interest in school was learning about science and she commented that she attended a science club after school. Abby stated that she had a greater interest in science than in math, because she found math to be more difficult. She said the difficulty stemmed from trying to understand the meaning of variables and functions presented in her mathematics class. When asked how her teacher presented the mathematical subject matter, she stated that he taught out of a book and provided handouts to the students. When asked if the teachers used more examples and explained each step individually, Abby stated that it would be easier for her to learn with that type of teaching style.

When Abby was asked to explain what motivated her to learn and she indicated her teachers were the motivating factor. When I asked her what it was about her teachers that motivated her to learn, she said it was because the teacher "explains everything in detail," allowing her to better understand the material. Abby also expressed an interest in being motivated by a monetary reward, but she felt that she would still be motivated to learn, even after having received compensation for accomplishing her schoolwork.

When the discussing collaboration in the classroom, Abby said it was more difficult to learn with others because she prefers to write things down and she has learned how to study on her own for the subjects she understands. Like many of her peers, she sought out collaborative partnerships when the subject matter was more difficult and she did not completely understand the material. Though she preferred to study on her own in subjects she was comfortable with, she was not averse to helping her friends when they needed her assistance. When asked if she has ever witnessed harassment toward someone that was more intelligent in a particular subject, she commented that the "non-smart kids" would call other students "nerds." She responded positively when asked if she thought the smarter students would try to not act as smart in response to the harassment.

Recollections of the NASA SOI program. Abby was able to recall two of the activities she participated in during the summer program. She recalled building and launching spaceships with her friends and she remembered using pressure as the launching mechanism. When asked if they did anything following the launch she was able to recall they measured the distance that each rocket flew, but she could not recall discussing any practical application for the activity. Abby was also able to remember the egg drop activity. She discussed using tissue paper as the cushioning material and that her construction prevented the egg from breaking. She understood the practical application of the activity as being related to the Mars Rover. Abby was one of the students that were selected to visit the Kennedy Space Center. She recalled touring the facility, but could not remember much about what she saw, aside from "different kinds of rockets and stuff." When she was asked if her participation in the summer program increased her interest in math and science, she said that it did increase her interest in science.

Native Americans in the curriculum. Like her peers that attended the summer program, Abby could not identify an instance where she was ever taught examples of Native Americans as natural scientists or engineers in a normal classroom setting.

Long-term goals. . Abby's long-term goal was to enter a university on the east coast and major in veterinary medicine. She felt she had a responsibility to complete her college education because her immediate family believed she had the requisite intelligence and ability to see her way through a college program. If so, she would be the first person in her family to complete a post-secondary education.

Rose. Rose was a young woman who was in the 10^{th} grade. She participated in the NASA Summer Program as a 7^{th} grader. Rose had plans to become a law enforcement officer after she completed high school. She was engaged and interested during the interview and answered questions quickly and thoroughly. Like many of her peers in the summer program her mother was a strong supporter of her education and encouraged her to do her best in school and continue to college. She had an older sibling that had plans to attend college and she had extended family members that attended college.

Family. Rose, like many of her peers, had a strong maternal lineage that was her prime source of motivation regarding her educational goals. Rose commented that her mother did attend college, but Rose was unsure if her mother actually completed college. Regardless of her mother's educational attainment, Rose stated that her mother often inquired about her plans for her future and encouraged her to maintain good grades in school. Rose had an older sibling that had graduated from high school and planned to attend college in the future with the intention of studying medicine. In addition to her mother and older sibling, Rose had an aunt that attended college and who had been an excellent source of information about the college experience. Rose stated that her aunt had informed her that college could be a "scary" place, due to the size of the institution and the number of people in attendance. Rose had a younger sibling that Rose tried to motivate to attend school, but she said that it was a difficult thing to do since her sibling, "just doesn't like school."

Motivation and collaboration in education. Rose stated that she enjoyed going to school for the reason that she simply liked it, without going into detail about why. Rose stated that her mother would sometimes ask her if she wanted to stay home when her sibling was sick or had an appointment and Rose was quick to say that she would rather go to school. When asked if she enjoyed coming to school to learn math or science in particular, Rose stated that she enjoyed it mainly for math. She explained that she felt she caught on easily to the subject matter and she was able to understand the concepts, especially in geometry. She commented that she enjoyed solving equations and arriving at an answer. When Rose was asked if she saw science or math being used in her everyday life, she commented that she would sometimes help her mom make bread and she understood the use of math in making measurements for the ingredients for the items she made.

Rose made a point of discussing her participation in a class where she was able to work with her hands and utilize math to make measurements in the construction of different projects. When asked if she felt she was mechanically inclined and liked to "tinker," Rose answered "yeah." When Rose was asked if she preferred to work with her friends in a collaborative environment, she stated that she preferred to work on her own, because she felt that many of the students were just messing around in class and they did not want to be there. She claimed that the other students often tried to get the teacher "off track." She also stated that students would try to obtain her answers if they didn't perform the work as instructed by the teacher. When she was asked if she ever helped the students, she said "Sometimes." When she was asked to expand on the answer, Rose stated, "Because they don't listen, I don't know… they just don't get it."

When Rose was asked to discuss whether or not students would make fun of her for being smart in math, she explained she sometimes felt bad and would not want to try as hard in order to avoid the taunting. Rose explained that she shared her feelings with her mother and her mother told her to not let it get to her because the other students were "trying to bring you down to their level."

Recollections of the NASA SOI program. When Rose was asked if her involvement in the NASA Summer Program increased her interest in math and science, she stated that it did "in some ways." When she was asked to clarify her answer she commented that it was because of some of the things that she learned in the program, being able to use her hands in the activities, and working outside of the classroom. She recalled that they built and launched rockets as well as the egg drop activity. She enjoyed the opportunity to compete with her friends and felt that she would work hard to get an A. She commented that she did not recall using any of the activities that she learned that summer in any coursework in the three years following the summer program.

Native Americans in the curriculum. Rose did not recall of any examples of Native Americans as natural scientists or engineers being taught by teachers in her school. When asked if it would make her feel good if her teachers would spend time relating stories of Native Americans as examples of capable scientists and engineers, Rose responded positively to the question.

Long-term goals. . Rose aspired to one day become a police officer in a large metropolitan area. She understood the educational requirements for the position of a police officer. When asked why she chose that as a professional goal, Rose responded that it was something she had wanted to do since she was a small child and she would take pride in being able to serve others.

Heidi. Heidi was a young woman in the 10th grade. She attended the NASA Summer Program while she was a 7th grader. Heidi was relatively quite during our interview and answered most questions with a yes, no, or an occasional head nod. When she did provide an extended answer it was well presented and thoughtful. Heidi indicated that none of her family members were college graduates, but many of them had completed high school. Even though her immediate family did not have post-secondary education in their history, she did comment that her family did encourage her to go to college. Heidi indicated that she enjoyed the hands-on nature of the summer program and that she wished her classes utilized more experiential activities. Heidi aspired to be a psychologist one day and she recognized she must attend college to pursue this goal.

Family. Heidi indicated that the majority of her family members had not completed high school and none had attended college. She was not specific regarding the educational attainment of family members, only that “most of them did graduate” from high school.

When she was asked whether any of her family ever spoke with her about attending college, she replied that they did, “pretty much all of them,” and they told her she needed to raise her grades if she wanted to attend. Heidi did not mention whether she had any siblings or if they attended school. When asked if she wanted to attend college, Heidi commented that she did and she wanted to study to become a psychologist so “she could help others.” Heidi commented that she had a friend who attended a university and majored in nursing. When Heidi was asked if her friend shared any insights about attending college, Heidi commented that her friend spoke about the need to “learn different…. measurements and stuff.”

Motivation and collaboration in education. Heidi did not express a strong desire to attend school. When Heidi was asked if she ever thought about what motivated her to come to school and learn, she answered, “no.” When she was asked how she felt about school in general, she indicated that there were days she liked coming to school and days that she did not. On the days she enjoyed school, she commented that it was when there was a sense of cooperation in the classroom. When asked to clarify whether the cooperation was something between the students or between the students and the teacher, Heidi indicated it was when the teacher expressed an excitement about teaching and shared this excitement with the students. Heidi felt that her teachers did not spend as much time with the students as she felt they should. When she was asked how she would teach the class, if given the opportunity, Heidi said, “I’d answer everybody’s questions, but when someone needs help, I’d try and do it on the board.” She felt the teachers were not as involved with the students as much as they should be.

When Heidi was asked to describe her preferred method for learning in the classroom, she indicated that it was easier for her to learn when she was provided examples and had the opportunity to use her hands when doing an activity. Heidi referred to the activities that she did during the NASA summer program as an example of a hands-on learning experience that she enjoyed. Heidi was asked to describe her feelings regarding math and science and she readily indicated that she did not like math. Her aversion to the subject was due to the fact that she did not have confidence in her ability to perform some of the mathematical operations. She did not feel the same way regarding science and indicated that she enjoyed some science subjects, specifically biology. She enjoyed the opportunity to diagram cells and it increased her curiosity in the subject. She indicated that her school has microscopes, but her teacher did not utilize them in her class. Heidi stated that her science teacher most often wrote on the board and left the students to refer to their textbook without providing examples or conducting hands-on activities.

Heidi commented that she enjoyed working with her friends in class, but it does not happen as often as she would like it to. She did not elaborate on the times when she did work with her friends, but she did indicate that when she did, it helped to make the learning process easier. She commented sharing her work with others helped her determine what mistakes were made and how to correct those mistakes. She also commented that many of her friends also had difficulty with math, so she was not the only one that did not understand some of the subject matter. When asked if she saw other students making fun of students for being smarter in a particular subject, she answered positively. Heidi was asked if friends had ever made fun of her and she indicated that they had. When asked how it made her feel, she said it made her feel "angry." She clarified that she was angry with herself, but she wasn't positive when asked if this feeling made her less likely to show her intelligence in class, in order to avoid the taunting of her classmates.

Recollections of the NASA SOI program. Heidi was able to recall one activity that was accomplished during the summer program, the egg drop. She described how she built a vessel that protected her egg from breaking and she also recalled that the instructor shared the real world relevance of the project as an example of how a rover would be protected on its arrival at Mars. She stated that she enjoyed being able to use her hands in the activity, but she could not recall any additional activities unless prompted. When Heidi was asked if the summer program increased her interest in math and science, she commented that her interest was increased in science, but not math. When she was asked to elaborate on why the summer program made a difference she said, "Just to learn…just made me want to learn more about chemicals and different things.

Heidi also had the opportunity to visit the Kennedy Space Center and attend a launch of the space shuttle. Though the launch was scrubbed, she did visit many of the facilities around the center. She indicated that the tour piqued her interest and she wanted to learn more about, "how they made all that stuff." While she enjoyed the tour and it increased her interest, she did not recall the specifics of what she saw or did while she was there.

Native Americans in the curriculum. Like her peers, Heidi could not recall an instance where her teachers discussed examples of Native Americans as natural scientists or engineers. She did indicate that she would like the opportunity to learn more about them in class and that it would be helpful to her.

Long-term goals. . Heidi indicated that she hoped to one day attend college and become a psychologist. When asked where she thought she would be in ten years from the date of the interview she stated that she would probably still be in college. Heidi understood that attending college would allow her to, in her words, "So that I can do what I want to do."

Ajay. Ajay was a young man in the 8th grade and volunteered to attend the NASA summer program as a 5th grader. Ajay aspired to become a professional athlete after attending college at a northwestern university. Ajay had a gregarious personality and was deliberate and talkative during the interview. He answered the questions thoughtfully and was not prone to one-word answers. His parents engaged him regarding his choice of universities to attend and Ajay indicated that he was set on two particular universities due to their athletic programs. Ajay also looked beyond a career in sports to possibly owning a business one day. Ajay displayed a penchant for video games and had a vision for his future and was already planning his path at a young age.

Family. Ajay's indicated his parents did not attend or graduate from college. He commented that neither of his parents graduated for high school and that family circumstances led to their dis-enrolling from high school. He said, "I was kind of a big choice in my mom's life," when he discussed her reasons for leaving high school early. Regardless of his parents' educational background, they exhibited an interest in his pursuit of a higher education. Ajay did not discuss any extended family members and whether or not they expressed any interest in his educational goals. As the oldest of his siblings, Ajay responded positively when asked if he was someone that his siblings looked up to. Ajay commented that his parents would sometimes provide him math problems to work out as an effort to encourage him to learn. When asked to provide an example, Ajay said "They give me like…what is x/14 times 3 times 89."

Motivation and collaboration in education. Ajay expressed a moderate interest in attending school, primarily to see and interact with his friends. He commented that working with his friends on different school subjects made it easier to learn. When asked if a particular subject was really hard, did working with his friends make it easier to learn, Ajay said, “Because I can turn to them and ask them what it is and they’ll tell me.” He identified his math as his favorite subject and commented that he enjoyed challenging his brain working with numbers. He also stated that his math teacher was good guy and that he was “fun” because he gave examples in class and discussed the reason why they are learning the subject Ajay also identified math classes he could take once he was in high school, specifically geometry, algebra II, trigonometry and calculus. When asked if he enjoyed science in addition to math, Ajay commented that he enjoyed his Earth science class and learning about geologic activity, specifically volcanoes and earthquakes. When he was asked if he could relate the things he learned to examples in his everyday life, Ajay commented that he could see math in the prices he saw at the store and science in the flowers, clouds, snow, and rain around him. Ajay pointed out a particular time his interest in science was piqued when he accidently cut his hand, which led him to wonder about the cells that were in his blood.

Ajay’s interests outside of the classroom tended toward video games. He understood a relationship exists between mathematicians and solving problems. He expressed an interest in software programming when told computer scientists program many of the videos games that he enjoyed playing on his Xbox. Ajay said that he should learn something outside of sports in the event that he was injured. He said, “if I had (to be) put out of the game, then I’d have to learn how to work on the side.” Ajay also expressed an interest in music and possibly a career as a rap artist.

When he was asked to explain what motivated him to come to school, Ajay provided an answer that was not discussed by any of his peers in the summer program. He said, “I’d say mainly, it would have to be about a girl." Ajay responded positively when asked if his motivation to learn was so he could impress a girl with the things he was able to learn.

Recollections of the NASA SOI program. Ajay was quick to identify the activities that he participated in during the NASA Summer Program. Unlike many of his peers, Ajay was able to identify two of the activities without prompting from the interviewer. He recalled the rocket building and launch activity, followed by the egg drop. Ajay commented that he enjoyed building the rocket and that he liked to learn by building things. Ajay was asked if his teachers did activities in class where he was allowed to build things, and he responded that they did not, but he wished they did. When he was asked to rate how the summer program changed his feelings about math or science, on a scale for 1 to 10, with 10 being the highest score, he quickly stated, "I'd say about a 10."

Native Americans in the curriculum. Like his peers in the summer program, Ajay could not recall an instance where his teachers provided examples of Native Americans as natural scientist or engineers. He answered positively when asked if he would like his teachers to give examples of Native Americans as natural scientists and engineers.

Long-term goals. . Ajay had plans to become a professional basketball player, but he understood that he needed to have a fall back plan if, for some reason, he was injured and could not play basketball. Ajay would like to study business so that he could own and manage a business someday, perhaps a retail men's clothing store. Ajay identified the particular universities that he would like to attend and the reasons why he chose those institutions.

Stacey. Stacey was a young woman in the tenth grade. She was in seventh grade when she participated in the NASA Summer Program. Stacey aspired to attend college one day, become a counselor, and return to her community to help others. She was motivated by immediate and extended family members that had taken an interest in her success and who encouraged her to attend college. Stacey had spent a good portion of her childhood moving from place to place and had attended much larger schools than the one she was currently attending. Attending different schools gave her the opportunity to experience a wide range of teaching styles and helped her determine the best method for her to learn. Stacey was moderately interested in science, but was not an interested in mathematics, primarily because of the methods used by her math teacher.

Family. Stacey had spent the majority of her childhood living with close and extended family members in a variety of communities, some far removed from northern Nevada. She commented that her aunties, one in particular, had been instrumental in motivating her to attend college. Stacey indicated that while her aunties attended, but did not graduate from college; they still encouraged her and shared their college experiences with her. When asked if the auntie who focused on Stacey the most, shared what she studied, Stacey pointed out that her auntie was more interested in focusing on what was important for Stacey. For example, Stacey said, "she never talked about her (auntie), like things were always based on me and my life."

Stacey commented that her brother had also been a strong supporter of her education and had encouraged her to attend college because, as Stacey said, "he didn't want me to be stuck on the reservation and not doing anything." Her brother also encouraged her to be good at math because as she said, "it's like an everyday thing and he didn't want me to look stupid when I go somewhere."

Motivation and collaboration in education. Stacey was not particularly keen about attending school in Owyhee. When asked how she felt about math or science, she said, "Honestly, I don't like math or science." When Stacey was asked to elaborate on her answer she said, "other schools that I've been to, like, I've been real interested in math and science cause they're, like, more hands-on learning with stuff, and then here they just talk about it and I think that's when I lose my interest in it." She commented that she attended a larger school and her teachers there were more engaged and used a variety of teaching methods that included hands-on activities. Stacey commented that she enjoyed learning through the use of examples and hands-on techniques. She likened what she did during the NASA Summer Program to methods her teachers had once used at a different school. Since she returned to Owyhee, she felt that her teachers were not as engaged and tended to only teach from the board and not engage the students in activities. When asked if the teachers at Owyhee ever used practical examples in teaching the subject matter, Stacey said, "every once and awhile, if you keep asking for it." When she was asked how she would teach an Earth science class about volcanoes, if given the opportunity, Stacey said, " probably have…students pair up and try and build one." Stacey commented that she once had a teacher that allowed students to build science projects and asked her if she wanted to build a volcano, but she said no, because she was "too shy."

Stacey commented one of the reasons she found it difficult to be interested in math or science in her present school was because some of the students are disruptive and they are "really, like, obnoxious and, like, don't like to learn about things." This was one of the reasons she preferred to study by herself and avoided collaborating with other students. Stacey likened working with other students in the same manner she would if playing sports.

She said that she gets frustrated with people that do not know how to play the sport and it was easier to do it on her own. She commented that the same goes for her studies. When asked if she ever helped others with schoolwork, she indicated that she did, but only after she had finished her work first. She was not averse to helping others entirely.

Stacey indicated that her motivation to learn comes from an internal desire to know more about things that are important in her life. One example she gave was when she was injured playing volleyball. She injured her leg and her knee, so she became interested in learning more about the structure of her bones and how they functioned. In the process, she learned that she had fractured the tip of her femur and dislocated her knee.

When Stacey was asked if her classmates made fun of those students who were better at a particular subject, she indicated that people were often called “school boy or school girl” as a negative connotation regarding intelligence. When asked if she has ever been called a “school girl” she commented that she had, but felt it was a sign of honor, one to take pride in rather than to feel bad. When Stacey was asked if she preferred reading about a subject in a book or learning by actually seeing and touching an object, she said, “I prefer that I actually do something with it.”

Recollections of the NASA SOI program. Stacey was able to recall one activity that occurred during the summer program, the egg drop. She commented that her instructor shared with the students the practical application for the egg drop and how it could relate to a Mars rover. She commented that she enjoyed the hands-on nature of the program and said, “I like the actual thing doing something instead of just sitting in class.” When Stacey was asked if the summer program increased her interest in math and science she said, “It kind of increased it." When she was asked to rate her increased interest on a scale from 1 to 10, 10 being the highest, she rated her increased interest probably a three or a four.

Native Americans in the curriculum. When Stacey was asked if her teachers ever presented examples of Native Americans as natural scientist or engineers, she said, "no, just white people." She commented that seeing examples of Native Americans would make her feel good and help her build her self-confidence. "I guess the society now is based on white people."

Long-term goals. . Stacey aspired to one day attend college and enter a career as a counselor. She indicated that she would like to return to her community and work with adults in a social work capacity, hoping to make a difference in their lives.

Robert. Robert was a young man in the 9th grade. He participated in the NASA summer program as a 6th grader. Robert was engaged and articulate during the interview and answered the questions in a thorough and thoughtful manner. Robert aspired to be a professional musician one day, but he also expressed an interest in science, specifically astronomy. Robert commented that his grandmother was the major influence in his life regarding the importance of a college education. It was interesting to note that Robert spoke about a specific teacher that took the time to share aspects of her college experience and the importance of attending a post-secondary institution as a means to a better quality of life.

Family. Robert did not share details about his immediate family, but he did comment that his family stressed the importance of a college education in that, as Robert said, "it builds my future." Robert did mention that his grandmother took the time to encourage him by saying that he could do anything if he went to college. Robert commented he thought his grandmother had attended college at one time, but he could not remember if she actually graduated or what she studied while attending. When he was asked if his grandmother ever encouraged him to study math or science in particular, Robert reminisced about how he felt she was being mean to him by making him study and then he realized, “I really needed it.” He went on to say that she wanted him to succeed in life. Robert did not discuss any siblings or additional extended family members and their respective education levels.

Motivation and collaboration in education. Robert did not express a great deal of enthusiasm regarding attending school. He commented that some days were good and some days were bad. The good days were those in which he felt prepared and he accomplished the homework that was assigned and/or performed well on tests. He commented that he enjoyed the feeling that came with doing well in school and was motivated by the sake of learning something new. When asked what motivated him to learn science, Robert said, “just to get smart.” When asked if he felt that same way about math, Robert was not as enthused as he was about science. He understood that math was something he had to learn, but he did not enjoy the process as much as he did science. Robert elaborated that if he learned something quickly, it was because he was interested in the subject. Robert answered positively when asked if he wanted to learn more about a subject if he knew he was going to apply it in his life. He commented there were times that his friends would “mess” with him, but if they kept “on task” they would be able to study and accomplish their work Robert stated that he enjoyed working with his friends on assignments that were difficult, but only if they concentrated on what they were doing. He also commented that he would often study with his friends at home and collaborate on homework assignments, because, as he said, “sometimes our parents make us work on math whenever I come over… or he comes over.”

When Robert was asked if he would enjoy math more if he were provided examples of how math applied in the real world, he answered that it would, because it would be easier and more interesting for him. When he was asked if he ever felt anxious about math or science, he said that he did, only when he did not feel that he had prepared well enough ahead of time, specifically when it came to taking a test.

Recollections of the NASA SOI program. Robert was not able to recall much about the summer program until prompted. He did recall building and launching rockets, but was unable to recall the egg drop activity. When asked if his interest in math or science was increased after the conclusion of the program, he said, “science. Not so much in math.” When he was asked if he did much math during the program, he commented that he did not. He did state that he enjoyed the science aspect because he liked talking about space.

Native Americans in the curriculum. Robert could not recall an instance where his teachers ever presented examples of Native Americans as natural scientists or engineers. He responded positively when asked if he would enjoy learning more about his ancestors and their ability to observe and build structures based on their observations of the world in which they lived.

Long-term goals. . Robert had plans to become a singer/songwriter in a place far removed from Owyhee. He gave Phoenix and Miami as examples of places where he would like to live because, as he put it, “it’s hot there.”

Thomas. Thomas was a young man in the 8th grade. He participated in the NASA Summer Program at the beginning of 5th grade. Thomas appeared to be a thoughtful and entertaining young man with a very clear vision of where he wanted to attend college and the course of study he would like to pursue. Thomas answered the questions with careful deliberation and thoroughness. He seldom answered a question with only a yes or a no. Thomas understood the importance of attending college and how, by doing so, it would improve the quality of his life. Thomas' immediate and extended family members were a source of encouragement toward pursuing his educational goals. Even though he was only in 8^{th} grade, he already had detailed plans for his education.

Family. Thomas' parents had dissimilar educational backgrounds. His mother attended college and graduated with a Bachelor of Science degree. His father immigrated to this country and did not attend college. Thomas did not discuss whether his father completed high school. Thomas also had a sibling that graduated from high school and worked in the community, but Thomas did not discuss his sibling's educational background. His grandmother attended a Native American tribal college and she encouraged Thomas to pursue his education beyond high school. When he was asked why she encouraged him to go to college, Thomas said, "(to) get a better life than she had back then." She also shared with Thomas the challenge of attending a school many miles from home and how it could be intimidating at first, but would get better over time. Though his grandmother had shared her experience at college, Thomas was not able to remember what she studied or if she graduated from college.

Motivation and collaboration in education. Thomas commented that he felt his interest in school was "slowly coming, like going downhill." When asked to explain the reason why he felt that way, Thomas stated that he felt his teachers were not very patient with the students and had little tolerance for errors. "If you don't do something right, the teacher will yell at you." When asked to provide an example of an error that would elicit anger from the teacher, Thomas said, “like, write your name on the wrong side of the paper.” He said, “it’s like the teachers are getting more strict.”

When asked if there were times when school was more enjoyable, Thomas commented that he liked to have fun in the classroom and be engaged in hands-on activities, otherwise he would shut himself off from the learning process. Thomas commented that only a couple of his teachers used examples to explain course material, while other teachers would only teach from the book or at the board, exhibiting little patience when students made mistakes. Contrary to many of his peers in the summer program, Thomas found enjoyment in math because his teacher engaged the students and used examples to convey the subject matter. If given the opportunity to be a teacher for the day, Thomas commented that he would have activities for the students to learn, thinking the students would be more engaged.

When Thomas was asked to describe a time when he worked with his friends in attempting to learn something they didn’t understand, he commented that it was something he “rarely” did Thomas explained that he does help his friends in math class when they have difficulty with the subject. He commented that he helps them work through the steps by showing them examples and how to work through the problem. Thomas stated that he gets a “little bit” of satisfaction from helping them and when they express an appreciation for his help

Recollections of the NASA SOI program. Thomas’ interest in math and science was increased following the completion of the NASA Summer Program because he enjoyed the opportunity to work with his hands in the program activities. Thomas immediately recalled working on both the egg drop experiment as well as the rocket build and launch. He described in detail how he built his egg drop lander and how he competed with his friends in the rocket launch activity. It was interesting to note that his first recollection of the summer program was how nice the people were and how much fun he had doing the activities. When asked if it felt like school to him, he commented that it did not, but he learned something in the process anyway.

Native Americans in the curriculum. Similar to his peers in the summer program, Thomas could not recall an instance where his teachers ever presented an example of Native Americans as natural scientists or engineers. Thomas would enjoy the opportunity to learn more about his ancestors and the role they have played in American history. Thomas cited an example of an individual that he admires who has made significant contributions to the history of his tribe. Thomas also commented on meeting a very high-ranking public official and how he was inspired by the encounter.

Long-term goals. . Thomas' long-term goals were focused on attending one of two particular universities; one overseas and the other on the east coast. He intended to study medicine with the career goal of becoming a surgeon. He had an extended family member that worked in the medical field and used that individual as an example of someone that used their education to improve their quality of life. Thomas had a personal goal of helping others and would one day like to make a difference in his community and make his family proud of him.

Carmen. Carmen was a young lady in the 11th grade. She was one of two students who chose to be interviewed without the use of a recording device. This narrative was based on my handwritten notes from her interview. I found Carmen's comments to be thoughtful and honest. Carmen understood the importance of her high school education, but she did not have any particular area of study to pursue in college or for a future career.

Family. Carmen was clear in her desire to attend college one day. Early in the interview she commented that her family stressed the importance of completing high school and for her to attend college in the future. However, she noted that her mother and grandmother did not complete high school and she was not specific on the education level of her father. When asked if her parents encouraged her to study math and science specifically, Carmen answered in the negative. Carmen did not discuss any family members, aside from her parents and grandmother, who were instrumental in her education or future plans in life.

Motivation and collaboration in education. Carmen was motivated to attend school primarily because of the friendships she had established at school. She was quick to comment that she enjoyed collaborating with her friends in solving problems and doing homework together. She found enjoyment in answering questions that her friends asked and how it made her feel good about herself. She also commented that she enjoyed school because it was fun and she had the chance to get out of the house. Carmen indicated that she understood her high school education was the key to being able to attend college one day. Her motivation to study was intrinsic in nature. She indicated that she enjoyed learning new facts and that she liked to visualize things she was studying. She described how she enjoyed drawing atomic and cell structures and the participatory aspect of her science education. Carmen also commented that she enjoyed making things and working with her hands. She described herself as mechanically inclined and even enjoyed working on her car. She commented that she was able to change a flat tire if necessary. Contrary to many of her peers in the summer program, Carmen expressed an interest in math and how she enjoyed being able to visualize graphs. She felt that she was good at math and "gets the hang of it." When Carmen was asked what motivated her to learn math and science she said that it was necessary for her to do so that she could graduate from high school, but she also commented that she was motivated by the opportunity to "better yourself."

Recollections of the NASA SOI program. Carmen recalled a few of the activities that she participated in during the summer of 2010. Her strongest recollection was the opportunity to attend a space shuttle launch at the Kennedy Space Center in Florida. While she didn't get a chance to actually see the shuttle launch due to a launch delay, she commented that she enjoyed visiting the center and learning new things about the space program. As for the specific activities she participated in, Carmen recalled building rockets and hot air balloons. She commented that she liked the hands-on nature of the program and being able to make things during the week. Carmen also indicated that she enjoyed some of the math that was required as part of the activities. While she commented that participation in the summer program was fun, Carmen said that she had always been interested in science and the summer program did not change her feelings much.

Native Americans in the curriculum. Carmen could not recall of a time when her teachers used examples of Native Americans as scientists or engineers. She jokingly commented that the only Native American engineer she was familiar with was me!

Long-term goals. . Carmen did not express any particular field of study she wanted to pursue in college or what she might want to do as a career. When asked where she saw herself in 10 years, she indicated that she was not sure, either in school or working at a job.

Nicky. Nicky was a young lady who attended 10th grade. She participated the IMU SOI as a 7th grader. She was one of two students who chose to be interviewed without the use of a recording device. This narrative was based on my handwritten notes from her interview. Nicky was an enjoyable person to interview. I found her to be an engaging young lady with insightful and detailed comments. She aspired to be a banker or pediatrician one day, after attending college.

Family. Nicky indicated that her parents were high school graduates. Her mother had attended cosmetology school and was currently working as a homemaker. Her father had enlisted in the military, but she did not provide details about his education or career beyond his military service. Nicky commented that her parents expected her to attend college one day and that she needed to do well in school to achieve that goal. She also commented that she had a large extended family, with 12 nieces and nephews. Nicky thought it was important to be a good role model for her nieces and nephews and she valued her family structure. "Family is a big deal." When she was asked if her parents encouraged her to study math and science, she commented that her father pushed her because he "wants the best for her" and wanted "her life to be better." Aside from her parents, nieces, and nephews, Nicky did not discuss any additional family members or their education levels.

Motivation and collaboration in education. When Nicky was asked how she felt about school in general, she commented that it was "just ok." She indicated that she enjoyed being able to attend with her friends, but she wished that school were more fun. She felt her friends were her primary motivator to attend school and she liked the opportunity to work with her friends and that her work was easier when she did. She enjoyed collaborating with her friends. Nicky commented that she liked to learn "science stuff" and learning "how things worked." She said that she enjoyed "being able to mix things" and she thought school would be more fun if there were more activities to participate in and if there were more field trips Nicky indicated that she enjoyed by being recognized for doing "good work" in the classroom She said it made her feel proud and motivated her to do "more good work."

Recollections of the NASA SOI program. Nicky's best recollection of the IMU SOI program was that she did not want to go. She commented that her father made her go and her mom drove her to the program. Even though she did not want to attend initially, she found the learning fun and she enjoyed the opportunity to make things. She recalled making a hand robot out of paper and strings. She also recalled the egg drop activity and having to build a structure to protect the egg. Nicky also indicated that she remembered doing "some math stuff," but she did not recall the activity where it was required." Another activity she recalled participating in was the rocket building and launch. She recalled measuring the distance that the rocket flew and how building the rocket was fun because she had a chance to work with her hands. When she was asked if her feelings about math and science had changed since the summer program, Nicky said it made her feel smarter, but she didn't feel that it had any "long-term impact." However, when asked if her interest in math and science was increased during the program, she said, "yes it did, but not so much in math." She indicated she was "not a math person." She was not asked to elaborate on what she thought a math person was, but when she was asked to describe what she thought a scientist was, she envisioned someone that looked like Einstein.

Native Americans in the curriculum. When Nicky was asked if she had learned in her classes of any Native Americans who were scientists or engineers, she answered that she had not. This was a common theme among all of the participants in the summer program.

Long-term goals. . Nicky's long-term goal was to graduate from college and become a banker. She also indicated that she enjoyed cooking, but did not indicate that it was something she wanted to pursue as a career. She commented that graduating from college would allow her to get a good job and "buy stuff and food."

Becky. Becky was a young woman in the 8th grade. She volunteered to attend the NASA summer program in 2010 as a 5th grader. Becky was not available to interview during my first trip to Owyhee, but she agreed to conduct a phone interview when she returned to school. I found Becky to be a very bright and engaging young woman who provided thoughtful answers to the interview questions. Though Becky did not express an interest in any particular field of study or possible career, she indicated a desire to attend college following her high school education.

Family. Becky's parents were both high school graduates who attended but did not complete college. Becky commented that her parents wanted her to attend college, but did not provide any specific guidance regarding what she should study or where she should attend. It was interesting to note that while neither of her parents completed their college educations, Becky shared that her grandparents were college graduates. She did not indicate whether it was her maternal or paternal grandparents. She responded, "I know my grandparents went to college." While she knew her grandparents were college graduates she did not know what they studied or the degrees that were conferred. Becky stated that she did not have any siblings that attended college, but she recalled an extended family member that had attended college, but she was not sure if the extended family member had completed her college education. Becky commented that her parents sometimes helped her with her homework and often encouraged her to study math and science. When she was asked to describe how they helped her, she said, "They relate it to real, like, stuff."

Motivation and collaboration in education. Becky found enjoyment in attending school due to the friendships she maintained. It was clear that her friendships were an important component to her school experience. When asked if her friends helped her get through the school day, she stated, “sometimes,” but she indicated that it was good to have her friends around when she had a hard day at school. When Becky was specifically asked if her friends were her motivation to attend school, she stated, “yep.” When questioned further, it was determined that she was motivated by a fear of failure in the classroom and that her friends provided her the strength to go to school. “So I don’t, like, fail…fail my class or I get held back.” She stated that she would sometimes think about not going to school, but would tell herself, “I should go to school because it (not going) is just going to make my grades bad.” She understood that not going to school would result in her grades suffering.

When Becky was asked if working with her friends made it easier to learn math or science, she stated that it did because, “sometimes it’s like… one person knows it and they’ll… explain it so we… the rest of use can understand it.” Becky stated that her teachers occasionally let her collaborate with her friends solving problems together in class or working on projects. She enjoyed the chance to work with others and stated that she would, “prefer they did it more,” when asked if she wanted her teachers to allow more opportunities for collaborative learning. When Becky was asked if her friends ever made fun of her for being good in a particular subject, she said they had, but it didn’t bother her or hurt her feelings.

Recollections of the NASA SOI program. Becky recalled attending the SOI program, but was able to only recall one activity without prompting. She stated that she remembered, “doing a lot of little projects and stuff.” When she was asked if she recalled any particular projects, she stated, “we did something with hot air balloons.” When Becky was asked whether she liked the subject matter of the projects or because she was able to “do the stuff,” she stated, “I think it was because we got to like actually, like, do it.” Becky indicated that she enjoyed learning when she had the opportunity to work with her hands. When asked if she was a "hands-on kind of person," Becky said, "yeah." When she was asked if there was a particular thing that she did not like about the summer program, Becky stated she felt that the program "started too early." Becky indicated that the early start was on the only downside to the program. When she was asked if the summer program changed her feelings about math or science, she stated, "it made me like it more." She went to say that she rated her change in interest "about a six" on a scale from one to ten, with ten being higher interest.

Native Americans in the curriculum. Becky stated that she could not recall a time when her teachers provided examples of Native Americans as being natural scientists or engineers. Like the majority of her peers, she stated that she had never been taught the subject matter in her classes.

Long-term goals. . Becky did not have a particular goal in mind for her education beyond high school, other than knowing she would attend college. She also did not express a desire toward a particular career. When asked where she saw herself in 10 years from the interview, she said, "probably in school."

Research questions. The research questions that were initially devised for this study were developed with the intention of determining the impact of the NASA SOI on increasing the interest of the students regarding math and science. During the course of the study it became clear that additional factors were involved in the participants' interest in STEM education and while the NASA Summer Program played a role, it was not the primary factor in these students being interested in STEM education. As a result, the research questions have been modified to capture additional factors that play a unique role in motivating these participants to attend school and possible study courses in the areas of science, technology, engineering, and mathematics.

Original research questions. The original research questions are provided below:

1. To what extent was the IMU NASA SOI weeklong hands-on educational program effective in motivating Duck Valley students to study STEM related courses in high school?
2. To what extent was the hands-on experiential format of the IMU NASA SOI essential in motivating Duck Valley students to engage in STEM activities?
3. To what extent were Duck Valley students more likely to study STEM related subjects after exposure to a short-term hands-on experiential education program focused on space/aviation related material?
4. To what extent did culture play a role in the motivation and engagement of the Duck Valley students when exposed to NASA themed educational material?
5. To what extent did cooperative learning play a role in increasing the interest of Duck Valley students during the IMU NASA SOI program?

Revised research questions. The revised research questions are presented below:

1. To what extent was the IMU NASA SOI weeklong educational program effective in increasing Duck Valley students' interest in science and mathematics?
2. To what extent was the hands-on experiential format of the IMU NASA SOI essential in increasing the interest of Duck Valley students to engage in STEM activities?
3. To what extent were Duck Valley students motivated to attend school following exposure to the IMU NASA SOI?

4. To what extent did culture play a role in the motivation and engagement of the Duck Valley students with respect to education?
5. To what extent did collaborative learning play a role in motivating and engaging Duck Valley students in science and mathematics?

Analysis. The interviews were designed to elicit feedback from the students regarding their experience in the IMU NASA SOI program and whether or not their interest in math and science was increased as a result of their participation. In addition, many of the questions sought to determine what factors played a significant role in motivating the students to attend school and perform well in their studies following their exposure to the NASA summer program. McInerney and Sinclair (1991) posited that an individual's motivation and achievement were the products of a "complex set of interacting goals that reflect personal, family, and cultural values" (p. 208). The questions posed in the interviews sought to determine whether a combination of factors, including participation in the IMU NASA SOI, were viewed by the students as being essential ingredients in their motivation to learn.

In order to identify the specific factors that were ingredients in the student's motivation to learn, which may have helped increase their interest in math and science, I analyzed the narratives using the NVivo 10 Qualitative Analysis program. The narratives were reviewed and the themes or codes that emerged from each of the narratives were input into the NVivo 10 program. The NVivo word frequency and query functions were used to identify similar codes or themes from the narratives that were not initially identified in my review. In addition, NVivo 10 had the capability to correlate coded data from elements of the literature review that were input as PDF files with the narratives of the participants. This allowed me to cross-correlate scholarly articles with the participants' narratives.

Effectiveness of the IMU NASA SOI. Analysis of the quantitative portion of this study resulted in acceptance of the null hypothesis that the IMU NASA SOI was not effective in increasing the interest of the participants with respect to math and science. However, one of the themes that emerged from the narratives told a different story than the quantitative data indicated. While less than 13% of the participants in the quantitative analysis indicated an increased positive attitude in science and math following the IMU NASA SOI program, more than 70% of the students in the case study acknowledged an increased interest in science following the summer program. Heidi found the summer program was effective in increasing her interest because, "…just made me want to learn more about chemicals and different things.

Some students found that the participatory nature of the program was an effective mechanism for increasing their level of interest. Skyler commented that being able to make things as part of the program had the effect of increasing her interest. "Doing fun things" was her motivator to learn during the summer program. Another effective strategy of the summer program was enabling the students to study and learn in an environment that was outside of their normal classroom routine. Rose commented that the summer program increased her interest "in some ways" by being able to work outside of the classroom and by using her hands in the activities. Some of the students expressed an interest in science that preceded their experience at the summer program, yet they indicated the summer program was helpful in fueling an additional level of enthusiasm for science subject matter. Bob commented that his interest in astronomy and space had increased more after attending the summer program. He shared that he always had an interest in space, wondering, "…what's out there. How does everything work in the universe."

One of the interesting themes that was derived from the narratives regarded students demonstrating an increased interest in science, but not necessarily with respect to math. When asked to clarify why their interest in math was not increased at the same level as science, many of the participants commented that math was not a focus of the program. Little, if any, math was used during the program. Robert indicated that the summer program was effective in increasing his interest in science, but "not so much in math."

Based on the narratives of the participants, a "big picture" view of their experience in the summer program was captured and was contrary to the findings of the quantitative data. While the baseline and follow-up surveys recorded the near-term experience of the students, it was clear from the narratives that the long-term recall of the participants reflected a different and more positive view of their experience. This finding supported Creswell's (2013) argument that one of the characteristics of qualitative research was it represented a "holistic account" of the research in that it provided a larger picture of the subject being studied (p. 47). For the majority of participants the IMU NASA SOI program was effective in increasing their interest in science, but not in math. The participatory experience was identified by many of the students as a mechanism to engage them in the learning process and appeared to be an effective tool for increasing their interest in the subject matter. It followed that the hands-on nature of the program was an important element in their summer experience.

Hands-on experience. Kolb (1984) argued, "Learning is the process whereby knowledge is created through the transformation of experience" (p. 38). The participants in the IMU NASA SOI were nearly unanimous in their belief that the hands-on nature of the summer program was essential in the learning process and a strong motivator in their desire to learn. Many of the participants commented on feeling connected to what they were learning by actually using their hands to build or create objects presented in the program curriculum. Participants identified two particular activities that they easily recalled three years following the summer program. One activity involved building a rocket from paper and using a foot operated pressure system to launch the rocket. The other activity required the students to build a container to protect an egg from breaking after being dropped from the roof of the school. Both activities required the students to work separately to design and build their own vehicles. Some students commented that they enjoyed the opportunity to personalize their vehicles and see how they operated compared to their classmates.

Skyler was one of the participants who recalled the rocket building activity as a memorable event. “We got to name our rockets, too. Decorate them and stuff.” Kate indicated that being able to “make stuff” was what made her experience in the summer program an enjoyable experience. The majority of the participants identified the hands-on nature of the summer program as something that they valued and wished they had a greater opportunity to practice in their everyday classroom. Steve indicated that he felt more “active” in the learning process and he enjoyed the opportunity to be actively engaged rather than just sitting in the classroom, being the passive recipient of the teacher’s lecture. Heidi shared that it was easier for her to learn when she was provided examples of the course material and when she was able to use her hands when doing an activity. She stated that the summer program gave her that opportunity and was more in line with her preferred learning style. Many of the students indicated that their preferred method of learning in the classroom was one where they were engaged in the activity and using their hands to create or build the item that was essential to the learning objective. Thomas commented that he liked to have fun in the classroom and using his hands in activities kept him engaged in the learning process, otherwise he became disinterested. Denise also indicated that she wished she had more opportunities to be involved in hands-on projects in the classroom, in the same manner that she had during the summer program rocket build session.

Dewey (1938b) argued, "all genuine education comes through experience" (p. 25). Through their narratives, the participants in the 2010 IMU NASA SOI both recalled and valued their experiences as having a lasting impact toward increasing their interest in science. The fact that many of the participants were able to identify specific activities three years beyond the time they experienced the event indicates that the participants may have utilized two of the four stages of adaptive learning modes posited by Kolb (2009b). Their ability to actively recall their experience could be parallel to Kolb's (2009b) adaptive learning modes of "reflective observation" of a "concrete experience" (p. 5). Whether the participants utilized "abstract conceptualization" and "active experimentation" in the years following their exposure to the IMU NASA SOI was unknown, but it could be argued that their participation in the activities of the summer of 2010 was a part of the experiential learning process identified by Kolb and Kolb (2009b).

Motivation. Vansteenkiste, Sierens, Soenens, Luyckx, and Lens (2009) found that some Diné students were intrinsically motivated to learn based on their natural curiosity, personal interests, and desire to learn for learning's sake. Vansteenkiste et al. (2009) argued that the students' intrinsic motivation was based on the Diné cultural value of success through self-determination. Aragon (2002) identified active participation in the curriculum as an important factor in the motivation of Native American students to learn. Many of the students at Duck Valley expressed a desire to learn for learning's sake and the positive feelings that came with doing well in class. They commented that active participation in the classroom with teachers who were actively engaged with the students was a motivating factor for them to attend class.

A desire to do well in class and keep her grades up so that she could attend college was a motivating factor for Denise. She stated, "…if I get a good grade, then it's going to be, like, be good for college." Another student who demonstrated an intrinsic motivation to learn was Skyler. Her primary motivation to attend school stemmed from the good feelings derived from being with her friends, being able to perform in front of her classmates, and "doing fun things." She singled out the opportunities she had in English class to perform poetry "out loud." She stated that it was, "just so I can feel good." Hope indicated that her motivation to learn was based on an internal feeling. She commented that it was not based on a need for an external reward. When asked if her desire to learn was based on internal or external feeling, she said, "Definitely internal."

One of the students looked beyond his high school and college education for the motivation to learn. Andy commented that he possessed a natural curiosity to learn new things because if gave him a feeling of accomplishment. He understood that obtaining an education would provide him the opportunity to improve his quality of life, his earning potential, and sense of independence. Andy believed that what he was learning was useful and essential to his everyday life and something that was just a natural extension to his existence. He stated, "There's always something there that you need to know." In a similar manner to Andy, Abby commented that she like coming to school because she "learned something new every day."

Only one of the participants expressed a singular extrinsic motivation to learn, driven more for monetary reasons than for personal satisfaction. Steve commented that he was not interested in coming to school and that a monetary incentive would make him more likely to attend. When he was asked if an offer of 10 dollars would be an incentive to work hard to earn an “A” in class, he clearly stated, "No, because it's only 10 bucks." He commented that a larger monetary incentive was required to motivate him to attend school. His measure of a larger incentive was stated, “a new phone.”

Lepper (1988) argued that intrinsically motivated students tend to seek more challenging assignments and thereby derive a greater level of satisfaction from the effort. Research in motivational theory suggests that students will seek out tasks that they find fun and engaging with some level of difficulty, yet they may seek to avoid tasks they find as too difficult and they may not be able to accomplish (Covington, 2000a; Eccles & Wigfield, 2002; Pintrich & Schunk, 1996). Csikszentmihalyi (1993) posited that it was the immediate subjective nature of an enjoyable task that motivated an individual to engage in the activity. Perhaps this was one of the key components of the IMU NASA SOI in that it gave the students activities to engage in from which they derived a level of satisfaction and enjoyment, thereby increasing their motivation to engage.

Extrinsically motivated students are less likely to seek difficult tasks and are more likely to put forth less effort to obtain the greatest level of external reward. Many of the participants in this study valued learning new material because it provided them with some level of satisfaction regarding their newfound knowledge. Brophy (2010) posited this type of intrinsic motivation was driven by a person’s desire to “want” to learn rather than a “need” to learn. The individuals in the IMU NASA SOI indicated that they enjoyed being engaged in the activities of the summer program, but they also demonstrated they possess they same level of motivation in their current school experience. Being engaged in the activities of the classroom that they find engaging and satisfying was a common them among these students and appears to help them enjoy their educational experience.

Cultural. Demmert, Grissmer, and Towner (2006) posited that one of the keys to educational success for Native Americans was to understand the importance of students' families and culture in their education. Thornton and Sanchez (2010) argued Native American students could become overwhelmed and lose motivation without proper support from those considered "key stakeholders" in the academic success of the student (p. 456). Thornton and Sanchez (2010) identify these stakeholders as "school, family, and the community" (p. 456). Family support has been identified an essential component to the academic success of Native American students and students from aboriginal communities (Epstein, 2011; Heavyrunner & DeCelles, 2002; McInerney & Sinclair, 1991; McInerney, Roche, McInerney, & Marsh, 1997). A major theme that arose from the participants' narratives was the importance the students placed on family involvement and encouragement. The majority of the participants identified key family members as being essential to their motivation to attend, persist, and graduate from high school. Many of the students indicated that immediate and extended family members provided encouragement and guidance with respect to their current education as well as future college plans. It was interesting to note that many of the students identified a female family member as the primary motivator with respect to their education.

Stacey indicated that her aunties encouraged her to pursue her education, even though that had not attended college themselves. She said her aunts were focused on her [Stacey] future and what was most important for her success. Stacey said her aunties' comments and concerns were, "always based on me and my life." In addition to her aunties, Stacey said that her brother was also a motivator and strong supporter of her education. Stacey said, "he didn't want me to be stuck on the reservation and not doing anything." Her brother also encouraged her to be capable in mathematics because he felt it was an important component of everyday life. Stacey said, "it's like an everyday thing and he didn't want me to look stupid when I go somewhere."

Robert commented that his grandmother often encouraged him to attend college because she felt he could do anything if he completed his education. Robert indicated that his grandmother would often force him to do his homework and he often felt she was being mean to him. He stated that he now understood why she was insistent that he complete his homework because, "I really needed it."

Like Robert, Thomas' grandmother was also a prime motivator for him to complete his education. Thomas stated that his grandmother had attended a Native American Tribal College and understood the importance of Thomas attending college. When he was asked why he thought she was so insistent, Thomas stated that he felt she wanted him to, "get a better life than she had back then."

Hope shared that her mother was a strong supporter of science education, going so far as to do experiments at home in order to increase her children's' interest in science. Hope said her mother was "really big on science." Hope stated that in addition to her mother being a college graduate, Hope's older siblings were as well. As such, all of her immediate family members were a source of inspiration and encouragement with regard to education.

Unlike Hope, Abby shared that she would like to be the first college graduate in her family. While her immediate family members had not attended college, Abby commented that her family were a source of encouragement because they felt Abby had the requisite intelligence to attend and complete college. Abby commented that she felt a personal responsibility to complete college because of the support and encouragement that her family extended to her while she was still in high school.

Becky was another student whose immediate family members had not completed college, but were sources of encouragement and support toward the goal of attending and graduating from college. She stated that her parents often helped her with her homework and encouraged her to study math and science. She stated that her parents provided homework examples that she could "relate to real, like, stuff."

Adding to the theme of maternal support for Native American students as a key component in motivation and persistence in education, Rose shared that her mother and an aunt had graduated from college and an older female sibling plan to attend within the next year. Rose's aunt had been a source of inspiration and encouragement to attend college and would often share her college experience. Rose said her aunt told her, "at first, it's scary" and "if you are not used to, like, big places and… You're going to have to get used to it."

While many of the students' parents provided verbal encouragement, a few actively worked with their child helping with homework and sharing examples of scientific principles. Ajay was a student whose parents actively participated in his education. He commented that they encouraged him to learn and would work with him by providing examples for his homework. When he was asked to provide an example of a problem his parents would give him to solve, Ajay said, “They give me like…what is x/14 times 3 times 89.”

Andy’s mother was the family member most responsible for encouraging him to attend college and she often conducted experiments at home to reinforce science concepts he was learning at school. A college graduate herself, Andy’s mother motivated her son to attend school by telling him; “he couldn’t live on the couch all of his life.”

The theme of maternal support, as the principal source of encouragement for many of the students, was significant. In a qualitative study by Lajimodiere (2011) in which she interviewed nine Native American women in positions of leaderships, she found these successful women all identified their mothers as their mentors, who encouraged them to attain college degrees. Of these nine women, eight held doctoral degrees and the ninth held a master’s degree with six honorary doctoral degrees (Lajimodiere, 2011, p. 62). Lajimodiere (2011) argues that Native American women of today are the “primary socializers of children and keepers of culture, language, world-view, rituals, and practices (p. 59). Perhaps the role of Native American women as the prime catalyst for motivating their children toward success in education was best summarized by one of the students at Duck Valley. This student identified a female family member that had done much for his tribe and he valued and took pride in what she had accomplished in her life. Her accomplishments made him proud and motivated him to make a difference in his community.

Collaborative learning. During the qualitative portion of the research, the term “collaborative” was used when questioning the learning strategies the participants might employ in the course of their schoolwork. I was attempting to determine if the students preferred working in groups in an effort to learn and make sense of instruction and material presented in the classroom. While the terms “collaborative” and “cooperative” have similar meanings, their use in the classroom can be defined separately. According to Matthews, Cooper, Davidson, and Hawkes (1995), collaborative learning was less structured, where the students actively worked together to reach a common goal and the instructor was not actively engaged in their work. In a collaborative learning paradigm the students were not formally instructed on how to utilize their social skills to work together. The students called upon the instructor only when they desired assistance. In a cooperative learning environment, the instructor was actively engaged with the students and formal instruction was provided on how to interact socially to accomplish an assigned task (Dallmann-Jones, et al., 1994). The term “collaborative” more accurately described the learning strategy the participants used given that their efforts were performed in a non-structured environment and the instructor was not actively involved in their problem solving efforts.

Some of the students in the IMU NASA SOI commented a few of the activities they engaged in during the summer program were collaborative efforts. However, most activities were completed by individual effort. Aside from the IMU NASA SOI activities, many of the participants commented that they found collaborative learning essential in their daily studies when the subject matter was difficult and hard to understand. Some of the students indicated the most difficult subject matter was mathematics and they relied on cooperative efforts to learn the material. From the discussions with the participants in the study, it appeared their collaborative efforts were unstructured gatherings that were not supervised or administered by their teachers.

Denise indicated that collaborating with her friends was an essential ingredient to her educational experience. She found that difficult subject matter was easier to comprehend if she worked with others. Another student that relied on her friends to help learn difficult subject matter was Skyler. She shared that mathematics and science were subjects where she collaborated with her friends to understand difficult concepts and work through challenging problems. She identified chemistry as a subject where she worked with her friends to understand the structure of atoms through the use of diagramming. Hope commented that working with her friends allowed her to compare results from homework and if her answers differed from her classmates, she said, "You can break it down…each step they did to get the answer." Some students preferred to work separately from their classmates, depending on their method of study. Abby shared that she would rather work by herself because she preferred to write things down and she was comfortable with subjects she understood. However, when the subject matter was more difficult, Abby followed her peers and worked collaboratively to accomplish her assignments.

Sanchez (2001) found that collaborative efforts between students was one of the preferred methods for maximizing learning at the community college level for Native American students. Dewey (1938) and Lewin (1935) valued the importance of group dynamics in collaborative learning. Dewey (1938) argued that in order for students to be involved in the democratic process, learning how to work collaboratively in the classroom would be a valued skill in a democratic society. Lewin and Lewin (1948) contended success toward achieving a common goal relied on the interdependence among individual members of a group. Swisher (1990) suggested that Native American students were more likely to value a collaborative atmosphere in the classroom because it was aligned with their traditional values and culture. The analysis of the narratives indicated the participants' valued collaborative learning as a means to gain knowledge of difficult subject matter. It would be informative to conduct a more detailed study on whether or not structured cooperatively learning in the classroom would be more beneficial for the students in gaining knowledge related to difficult subject matter than the less structured use of a collaborative learning paradigm.

Cultural border crossing. One theme that was not specifically addressed in the research questions, but came to the forefront during the interviews was the fact that none of the participants could identify a time in their formal classroom setting where teachers presented examples of Native Americans as natural scientists and/or engineers. Aikenhead (2006) posited teachers should act as "cultural brokers" between the student and the curriculum (p. 121). Teachers should provide the students with material to help them identify with their culture while bridging the gap to the subject matter being taught. Aikenhead (2006) warned that a gap could exist between a student's own culture and the predominant culture of the school when a teacher fails to recognize that a border exists. In the case of the Owyhee Combined School, the administration provided numerous examples of culturally appropriate material along the hallways of the school, encouraging students to be drug free and excel in school. Yet, when the students were interviewed regarding their curriculum, they were unanimous in their response that their teachers did not provide examples that they could culturally identify.

Stacey shared that she would like to see examples of Native Americans as scientist and engineers because it would make her feel more confident about herself. However, she said, "I guess the society now is based on white people." Andy commented that he would also like to hear about Native Americans who were professionals in the STEM fields. When asked if he would appreciate the opportunity to hear about their experiences and education, Andy said, “Yeah, that would be cool. I like talks like that.”

During the interviews, I asked the students if they wanted to hear a couple of examples of Native Americans and work they had done that represented their abilities as natural scientists and engineers. Every student expressed a desire for me to share the information. The first example I provided was the civilization at Chaco Canyon, a remarkable example of early Native American architectural achievement and astronomical understanding (Campbell, Windes, Stuart, & Kallestad, 2007; Luce, 2010). The second example I shared was work that my ancestors had accomplished at present day Moundville, Alabama. The Moundville archaeological site represented a complex arrangement of earthen mounds that were erected in a manner that suggested a complex social order and hierarchy (Knight, Jackson, & Scott, 2010).

Both stories were meant to demonstrate that our Native American ancestors were very capable of designing and building structures to support large populations centers. It was their ability to carefully observe the world around them and solve problems surrounding food and shelter that allowed them to survive and flourish centuries before Western civilization encroached on the North American continent. Providing examples such as these were meant to instill a sense of pride and accomplishment in the minds of the students and bridge the gap between their Native cultural and that which they have experienced in the Western educational paradigm. Sutherland (2005) posited that students who were able to bridge the gap between cultures with respect to science education were more likely to be intrinsically motivated and value their cultural identity.

Summary

The major theme that emerged from the qualitative data suggested that the majority of the participants of the IMU SOI program found value in the hands on nature of the activities they engaged in during the summer of 2010, thereby increasing their interest in science. While the quantitative data for the majority of the students did not show a statistically significant increase in their attitudes regarding math and science, their narratives told a different story. Their stories provided depth and meaning to their experience, where numbers alone were not indicative of the "big picture" (Creswell, 2013).

Going beyond the experience of the IMU NASA SOI program and it's impact on the participants' attitudes toward science and mathematics, the analysis of the narratives yielded themes that demonstrated the participants were motivated and engaged with respect to their education. An important theme to emerge from the narratives was the cultural influence the maternal side of the participants' families as a source of motivation regarding their education. While some of the participants spoke to the role their paternal family members had on their education, the majority of the students identified their grandmothers, mothers, aunties, and sisters as having a larger role in encouraging and motivating the students to attend and persist in their education. This finding supports previous research on the importance of female family members as a strong cultural component to the success of Native American students in education (Huffman et al., 1986; Macias, 1989; Rindone, 1988). Another theme that emerged from the qualitative data was the importance of collaborative learning on the participants' ability to learn more difficult subject matter. In the case of this study the most difficult subject matter to learn and understand, expressed in the narratives, was mathematics. This finding supports previous research on the importance and effect of collaborative learning on the motivation and engagement in Native American communities (Radda et al., 1998; Sanchez, 2001, Thornton & Sanchez, 2010).

Chapter 5: Discussion and Recommendations

I have often been asked why I chose to reenter graduate school after a full and successful career as a Naval Aviator, test pilot, and astronaut. What could I possibly accomplish that I had not already achieved in a professional sense? The answer to that question was a deeply personal one. My choice to pursue of an education in a technical field leading to a career in the United States Navy was the direct result of people that took an interest in me personally. Through their help and encouragement I made the correct decisions, academically and professionally. My success was due to maintaining a high degree of motivation and applying what I learned in the classroom to my work environment. In the second half of my life, it is my desire to "pay it forward" to the next generation of Native American scientists and engineers.

I chose to pursue a doctorate in education because I wanted to understand what motivates and engages Native American students to pursue science and mathematics and, in turn, add to the body of knowledge on what worked for this sample of Native American students. I have found that my role as an astronaut, someone who has flown in space, allowed me the opportunity to share my experience with audiences around the world. Not only the experience of flying in space, but the educational journey to arrive at such a rewarding personal and professional goal. For over 15 years I have spoken to thousands of people around the world, but my most enjoyable moments came from sharing my journey with students and educators. From these moments, I have seen how my stories sparked the imagination of students who seemed to possess a natural curiosity about space. They were interested in my experiences and they were engaged and highly motivated to learn as much as they could in the short time I spent with them.

Following my career as a Naval Aviator and astronaut, I became more involved in Native American education initiatives and became a founding member of a non-profit organization dedicated to improving the opportunities for Native American students to successfully pursue post-secondary education in the STEM fields. Though my college degrees were in applied mathematics and aeronautical engineering, I did not possess the requisite degree to effectively lead a non-profit organization dedicated to Native American education. Without an understanding of the history of Native American education and an understanding of the research and current literature on education in Indian Country, I would not be able to serve in a capacity that would benefit the organization and the youth that we wished to influence.

Prior to my pursuit of a doctorate in education, my only expertise on motivation and engagement in science and mathematics was a personal one. I wanted to understand if my personal experience was something that was supported by the literature. As a Native American, I was particularly interested to learn if research had been conducted that identified the factors that motivated and engaged Native American students to pursue studies in the areas of STEM. It was my hope that the themes that emerged from this study would be similar to what I experienced as a child and that I could connect my findings to what the current literature says about the motivation and engagement of Native American students in STEM. As a former NASA astronaut, I was particularly interested in the effectiveness of NASA-themed materials as tools to increase the interest of students with respect to science and mathematics. I was not disappointed in the outcome of this research!

Discussion

The purpose of this study was two-fold. First, to determine if there was a statistically significant difference in the students' attitudes regarding science and mathematics following participation in the 2010 IMU NASA SOI program. Second, by conducting a qualitative case study three years following the SOI program, I sought to determine the factors that motivated and engaged students on the Duck Valley Indian Reservation with respect to science and mathematics. In the qualitative case study I hoped to get a sense of whether the students' participation in the program had a lasting effect on their attitudes regarding science and mathematics and if their narratives would support the quantitative data.

The results of the quantitative analyses; the single-subject analysis, the paired sample *t*-tests, and the ANOVA, did not indicate a statistically significant effect of the summer program on the attitudes of the students with respect to science and mathematics over the course of the program (time), between genders, or a combination of both time and gender. However, the narratives derived from the case study indicated the students' attitudes toward science were increased following their participation in the summer program. The qualitative data supported previous research on the importance of family, culture, hands-on experiential and collaborative learning as essential components in Native American students' motivation and engagement with respect to education and science in particular (Cajete, 1999; Huffman et al., 1986; Macias, 1989; Radda et al., 1998; Rindone, 1988; Sanchez, 2001; Thornton & Sanchez, 2010; Yellow Bird, 2001).

A disturbing finding that was derived from the interviews was the absence of examples of Native Americans in the school curriculum and their representation as natural scientists and engineers. All of the students interviewed could not cite examples where their teachers provided examples of Native Americans as natural scientists or engineers. What was most disturbing about this finding was the comments came from Native American students who attended a school on a rural American Indian reservation.

While the results of the study indicated a disparity between the quantitative and qualitative data regarding the impact of the IMU NASA SOI on the interest of the students toward science and mathematics, the qualitative data provided insight into how the students were affected in the years that followed their participation in the one-week program. In addition, the qualitative data provided narratives that identified factors essential to the motivation and engagement of the students with respect to science and mathematics as well as education in general. Using the results of the qualitative research, the four research questions that were proposed and revised for this study will be addressed in this discussion.

To what extent was the IMU NASA SOI weeklong educational program effective in increasing Duck Valley students' interest in science and mathematics? Analyses of the quantitative data did not result in a statistically significant difference in the mean scores for the majority of students who participated in the summer program. However, results from three female participants did show a statistically significant change in their mean scores between the baseline and follow-up surveys. Two of the females, Heidi and Denise, showed statistically significant increases in their attitudes toward science and mathematics, while Carmen presented a statistically significant decrease in her attitude, though she expressed in her interview that she had always been interested in science. While these results do not demonstrate that the IMU NASA SOI was effective in increasing the attitudes for all of the students, the fact that the only students who were significantly affected were female should lead researchers to conduct a more detailed study on the effectiveness of such programs on Native American female students with respect to their male counterparts.

The qualitative data presented a different picture than the quantitative data about the effectiveness of the IMU NASA SOI on the students' interest regarding science and mathematics. The majority of students verbally expressed an increased interest in science due primarily to the hands-on, experiential nature of the program. Many of the students identified the lack of experiential learning in the classroom as a negative influence on their motivation to learn and they expressed their desire for more opportunities to actively participate in projects that were hands-on during the school year. This was not unexpected as previous research in the field of Native American education suggested this. Hands-on, experiential project curriculum and instruction was an essential component in the motivation and engagement of Native American students in the classroom, particularly with respect to female students (Cajete, 1994; Chacon & Soto-Johnson, 2003; Deloria & Wildcat, 2001, Reyhner & Eder, 2004).

To what extent was the hands-on experiential format of the IMU NASA SOI essential in increasing the interest of Duck Valley students to engage in STEM activities? The majority of the students who participated in the summer program were able to recall some of the activities they participated in even though three years had elapsed between the program and the interviews. Their comments reflected an appreciation for the experiential nature of the program and being able to use their hands in building and demonstrating their projects. The IMU NASA SOI curriculum provided the students access to concepts that were associated with NASA-themed content that covered subject matter from aeronautics (the science and practice of flight through the air), astronautics (the science and technology of spaceflight and exploration), cosmology (the science of the origin and development of the universe), food/nutrition, and robotics. Exposure to the NASA-themed material allowed the students to have access to concepts not normally found in their school curriculum. Aragon (2002) and Sanchez (2001) posited that active teacher involvement in the curriculum was important in motivating of Native American students. Since one of the objectives of the NASA SOI was to infuse NASA-themed concepts in the curriculum during the school year, the results of this study demonstrates students would benefit from increased inclusion of NASA-themed concepts throughout the school year, rather than just during a short summer program. The results of this study are evidence of the effectiveness of the IMU NASA SOI to motivate and engage the students to participate in STEM activities during the summer program. However, inclusion of this type of material throughout the school year could be effective in creating a higher level of motivation within the participating students and serve to increase their interest in STEM through the entirety of their educational journey. Educators do not have to use NASA-themed materials, so long as their choice of curriculum has content that allows students the opportunity to design and build projects requiring experiential hands-on learning that is motivating and engaging.

To what extent were Duck Valley students motivated to attend school following exposure to the IMU NASA SOI? Student motivation to attend school was varied across the participants and reflected a combination of factors, but was primarily intrinsic in nature and often the result of family support and encouragement. While the students did not specifically indicate that attendance in the IMU NASA SOI was a factor in their motivation to attend school, most of the students indicated that familial encouragement and example were factors in their motivation to attend class. The majority of students expressed an intrinsic desire to attend school because they enjoyed the opportunity to learn new things and their abilities in school would bode well toward success in their personal lives. Natural curiosity and personal interest in the subject matter have been shown to be important elements in the motivation of Native American students to learn and to become autonomous learners (Aragon, 2002; Brophy, 2010; Covington, 2000; Huffman, Still, & Brokenleg, 1986; Korkow, 2008; Rindone ,1988).

To what extent did culture play a role in the motivation and engagement of the Duck Valley students with respect to education? The majority of students indicated a maternal link existed in their motivation and engagement with respect to education. Most often, it was a female family member; grandmother, mother, sister, or auntie who was the responsible agent for encouraging the student to attend school and continue on to college. In some cases their mothers were active participants in bringing science and mathematical examples into the home through demonstration of scientific and mathematical principles related to food or cooking. From a cultural perspective, this supports findings of other researchers who posit that a strong family component was a culturally significant element in the lives of Native American students and their success in education (Cleary & Peacock, 1998; Rindone, 1988)).

To what extent did collaborative learning play a role in motivating and engaging Duck Valley students in science and mathematics? The majority of students identified collaborative learning as an important part of their classroom experience. Though it was not an everyday occurrence in the classroom, the students appreciated the opportunity to work with their friends to accomplish difficult homework or classroom projects. The subject the students most often cited as difficult, which they found easier to learn in a collaborative environment, was mathematics. The IMU NASA SOI activities were structured where the students engaged in collaborative learning on a daily basis and many of the students commented on the enjoyment they had engaging with their classmates. Brophy (2004) posited that students were motivated to learn when the classroom environment allowed the students to develop supportive relationships and minimized pressures that were associated with individual performance goals.

Recommendations

Practice. The following recommendations resulting from this research are made for teachers and administrators involved in primary and secondary education for Native American students:

1. Utilize NASA themed materials that engage students in hands-on activities to demonstrate and apply science and mathematical concepts throughout the school year. NASA themed materials are readily available, free of cost, to educators and are designed to meet core concepts that educators are required to cover during the course of the school year. The students that participated in this study highly valued the opportunity to engage their hands to build and operate articles that demonstrated concepts presented during their summer program. Experiential learning should not just be associated with summer activities, but be an essential component of all school curriculum.

2. Present historically relevant examples of Native Americans as natural scientists and engineers. Each students in this study commented that they were not exposed to culturally relevant examples of Native Americans and how their ancestors developed and demonstrated scientific and engineering concepts without the use of Western

science or technology. Prior research has shown that Native American students are motivated to learn when they can identify with their ancestors and apply it to their personal understanding of their place in history and add to their identity (Weatherford, 1988).

3. Provide students with opportunities to engage in collaborative learning in a non-competitive setting. The participants in this study indicated they valued the opportunity to work with their classmates, especially when the subject matter was difficult and their understanding of the material was lacking. Non-structured collaborative learning was preferred when working together to accomplish homework assignments.
4. Educators should be cognizant of their role as the responsible “border crossing” agent for their students and help to bridge the gap between Western culture and the predominant of the community. Being culturally responsive to the needs of the students is imperative to effectively assist the students as they make sense of the material presented to them relative to their personal experience and culture.

Future research. The literature that was reviewed for this study did not provide adequate empirical evidence to ascertain whether or not summer programs have a positive effect on the motivation and engagement of Native American students. Additionally, it would be beneficial to understand the impact that maternal influence has on Native American students and properly quantify through statistical analysis, the effect of strong maternal bonds on the attitudes of the students with respect to education. The following recommendations for future research are provided, in order to both quantify and qualify the effect of the factors identified in this study on the motivation and engagement of students regarding science and mathematics:

1. In order to properly generalize the results of research on the impact of summer programs on Native American students, it is imperative that properly designed experimental research is conducted. The use of appropriate survey instruments with high-reliability must be used to quantify the impact of summer programs on Native American students who participate and those who do not.
2. Conduct effective quantitative research on the impact of summer programs on the motivation and engagement of Native American students with respect to gender.
3. Conduct research on the impact of maternal support and role models on Native American students with respect to science, mathematics, and education in general.
4. Conduct quantitative research of the impact of summer programs on the motivation and engagement of the attendees, regardless of their ethnic background. Summer programs are a unique opportunity to motivate and engage students, but they are also a remarkable resource for quantifying the effects of the program in order to justify the financial expenditures required to conduct the programs.
5. Conduct a longitudinal study to determine if the students on the Duck Valley Indian Reservation, who participated in this study, chose to pursue post-secondary education in one of the STEM fields.
6. Conduct longitudinal studies on the participants of summer programs to determine the long-term effects of their participation and whether or not the participants tend toward post-secondary studies in the STEM fields.

Conducting future research. It is imperative that researchers who plan to conduct research in a Native American community make every effort to understand the cultural responsibility they have to the subjects of the research as well as the community as a whole. The importance of being respectful of the community's needs and following cultural protocols cannot be overstated. The guidelines set forth in the *Guiding Principles for Engaging in Research With Native American Communities* is an excellent resource to review prior to establishing the relationship with the community (Straits et al., 2012). I was fortunate to have the assistance of an individual that had already established a relationship with the community and helped me make the appropriate connections with leaders in the community and the Owyhee Combined School. Cajete (1999) introduced the concept of "sense of place" within a Native American community. Understanding my "sense of place" in the Duck Valley community made it possible for me to present myself as a "trusted ally" with the best intentions of becoming someone the community can trust to conduct honest and purposeful research. My responsibility to the community extends beyond the end of my formal research. It will be essential for me to return and share the findings of my research and listen to (and it possible) answer questions or concerns from the participants, their families, and the rest of the community. Conducting research culturally sensitive to the needs of the community allows for additional researchers to have access to the community so long as they also follow the guiding principles for research in Native American communities.

Summary

The results of this study supports previous research on the importance of hands-on, experiential learning in the motivation and engagement of Native American students with respect to science. This study also underscores the importance of summer camps as an opportunity, outside of the classroom, where students are free to use their creativity in a collaborative, non-competitive environment to broaden their base of knowledge. In order to quantify the effectiveness of summer programs, educators and researchers should conduct quantitative analyses that can serve as a metric and provide unbiased evidence for policy makers and educational institutions to justify funding these summer endeavors.

My research has been a very rewarding, albeit a challenging endeavor. I am extremely grateful to the community of Duck Valley for making me feel a part of their family and granting me access to interview their children. As a parent I understand how important it is to have trust in an individual that you allow to interact with your children. As parents we hope that our children are provided with the best opportunities to learn and that they are motivated to make the most of their education. While we want to be the most influential people in our children's lives, it is often someone outside of the immediate family that can have a greater impact on their future. Teachers spend a great deal of time, on a daily basis, with our children and we put a tremendous amount of trust in their ability to shape our children's future. Unfortunately, today's educational environment requires teachers to be focused on government-imposed standards that detract from their opportunity to be creative in the classroom and engage students in a meaningful manner to spark the students' creativity and motivation to learn. The legacy of Western influence on Native American education in the United States has left a deep wound on the psyche of this country's original inhabitants when it comes to the importance of learning. It is my hope that this study provides students, parents, educators, administrators, and policy makers insight into making sense of some of the factors that motivate and engage Native American students to pursue study in the areas of science, technology, engineering, and mathematics.

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Appendix A

NASA/ABT Pre and Post Test

a. I would like to belong to a science or math club.

b. I do not do very well in science.

c. I would like to be a scientist when I leave school.

d. I get bored when watching science or math related programs on TV at home.

e. Math is easy for me.

f. I would dislike becoming a scientist because it needs too much education.

g. I would like to be given a science or math book or a piece of scientific equipment as a present.

h. I usually understand what we are talking about in science.

i. A job as a scientist would be interesting.

j. I dislike reading books about science or math during my free time.

k. No matter how hard I try, I cannot understand math.

l. A job as a scientist would be boring.

m. I would like to do science experiments or math problems at home.

n. I often think, “I cannot do this,” when a science assignment seems hard.

o. I would like to teach science when I leave school.

p. I would like to teach math when I leave school.

q. Talking to friends about science or math after school would be boring.

r. I do not do very well in math.

s. A career in science would be boring.

t. A career in math would be boring.

u. I would enjoy having a job in a science laboratory during my summer vacation.

v. Science is very easy for me.

w. Working in a science laboratory would be an interesting way to earn a living.

x. Watching a video about science or math would be boring.

y. I usually understand what we are talking about in math.

z. I would dislike a job in a science laboratory after I leave school.

aa. I would enjoy visiting a science museum on the weekend.

bb. No matter how hard I try, I cannot understand science.

cc. When I leave school, I would like to work with people who make discoveries in science or math.

dd. I dislike looking at websites about science or math.

ee. I often think, “I cannot do this,” when a math problem seems hard.

ff. I would dislike being a scientist after I leave school.

Appendix B

Case Study Questions

1. What grade are you in now?
2. What has your family told you about the importance of your education and whether you should go to college?
3. What is the highest level of education that your family members have attained?
4. What do remember about participating in the 2010 NASA Summer of Innovation program?
5. What the most enjoyable part of the summer program? The least?
6. How do you feel about school in general?
7. How do you feel about math and/or science?
8. How your feelings changed about math and/or science since you participated in the IMU NASA SOI?
9. How do you view math or science as relevant in your everyday life?
10. Tell me what you think a scientist does for a living? How about a mathematician?
11. Why do you think you should go to college?
12. Did the IMU NASA SOI program increase your interest in either math or science? Why?
13. What motivates you to want to learn math or science?
14. What motivates you to learn in general?
15. How does working with your friends make it easier to learn math or science? Why?
16. What makes science interesting for you? What about math?
17. Can you describe for me an example of learning math or science by working with

your hands or by experiencing math or science in your everyday life?

18. How does your family encourage you to study math and/or science?
19. Can you describe how your friends help you or how you help your friends learn about math or science?
20. Have any of your friends made fun of you for being interested in math or science? If so, please describe for me what they said and how it made you feel.
21. Please describe for me how math or science can make you feel anxious.
22. Can you tell me a story that you have heard about Native Americans being natural scientists or engineers?
23. What are your plans when you grow up?
24. Where do you see yourself in 10 years?
25. Do you have questions for me regarding this research?

Appendix C

NASA IMU SOI Daily Activities

Day	Session	Activity	NASA URL	Description	Time Req.	Theme	STEM Field(s)
1	Morning	Propulsion – Rocket Races balloon powered cars	http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rocket_Races.html	Build and race balloon-powered cars	2 hrs	Rocketry	SEM
	Lunch		_				
	Afternoon	High Power Paper Rocket	http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html	Launch rockets using electric air pump or bicycle pump	2 - 3 hr	Rocketry	SEM
	Evening	Kickoff BBQ. Had approximately 60 people attend (families and people from the community). Showed off the paper rockets.					
2	Morning	Buzz Lightyear for Programming concepts (Robotics – Line 30	http://www.nasa.gov/externalflash/Buzz_Lightyear/web/	Space shuttle and ISS related games featuring Buzz Lightyear		Robotics	
		I want to hold your hand – have students build the opposable thumb for a "pick-up-and-move" activity. (Robotics – Line 11)	http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/I_Want_to_Hold_Your_Hand.html	In this activity, students construct a robot-like hand to demonstrate how data are collected when using robotic technology.	1.5 hr	Robotics	STE
	Lunch						
	Afternoon	Brush Bots – competitions held for racing and sumo wrestling.					
3	Morning	Space Food and Nutrition					
		NASA E-Clips, exercise in space, k-5 our world series, eating in space videos					
		Train like an astronaut – Fit Explorers. Teams did exercises at 6 different stations: situps, pushups, jump rope, running (lines), squats, and free throws. Winning team went to Mars – a local café for lunch.	http://www.nasa.gov/audience/foreducators/fitexplorer/home/index.html	Participate in a variety of physical and hands-on activities to encourage students to train like an astronaut.	4-6 hr	Life Here and Out There	S
	Lunch	None					
	Afternoon	Food pods - design and construction					
4	Morning	Paper kites					

IMU NASA SOI Daily Activities (cont)

Day	Session	Activity	NASA URL	Description	Time Req.	Theme	STEM Field(s)
4 cont.	Morning cont.	Paper airplane competition					
		Case of the Challenging Flight - foam airplanes	http://www.nasa.gov/pdf/636827main_Sci%20Filesguide4_00.pdf				
	Lunch						
	Afternoon	Foam airplanes cont.					
		Bag Balloon	http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Bag_Ballons.html	Build working models of hot air balloons using plastic bags.	2 hr	Aeronautic	S E
5	Morning	Launched bag balloons					S E
		Black Holes, Nebulas, planets, and other pictures along with explanations from Hubble website	http://hubblesite.org				
		Stellarium	http://www.stellarium.org	Free software that works on mac or pc to identify celestial objects and look up current locations of planets and constellations		Cosmic Connection to the Universe	S T
		Traditional Stories – NASA and the Navajo Nation	http://www.myboe.org/portal/default/Resources/Viewer/ResourceViewer?action=2&resid=106157	Explore the ideas of "life" cycle and transformation inherent in the scientific concept of stellar evolution, and the essential "properties" of the four sacred directions as told in a Navajo creation story.	1 hr	Discover Mother Earth and Father Sky	S
			http://astrobiology.nasa.gov/nai/Navajo-NASA/	Promote kinesthetic, experiential learning. Through movement, weave together the concepts of star formation, "we are made of starstuff," and the Diné Life Standards (courtesy of Diné College).	.05 hr	Discover Mother Earth and Father Sky	S
			http://astrobiology.nasa.gov/nai/Navajo-NASA/	Explore the Navajo story of First Man and First Woman creating the Navajo star patterns comparible to western constellations	1 hr	Discover Mother Earth and Father Sky	S

IMU NASA SOI Daily Activities (cont)

Day	Session	Activity	NASA URL	Description	Time Req.	Theme	STEM Field(s)
5 cont.	Lunch						
	Afternoon	Launched paper rockets again. (some students not there the first day for the paper rockets)					
		Egg Drop competition – landing Mars rover					

Appendix D

Protocol Approval

University of Idaho

Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010

Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

November 14, 2013

To: James Gregson
Cc: John B. Herrington

From: Traci Craig, PhD
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

Title: 'Investigating the Impact of the Idaho, Montana, and Utah NASA Summer of Innovation Program on the Motivation and Engagement of Native American Students on the Duck Valley Indian

Project: 13-274

Approved: 11/13/13
Expires: 11/12/14

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the above-named research project is approved as offering no significant risk to human subjects.

This approval is valid for one year from the date of this memo. Should there be significant changes in the protocol for this project, it will be necessary for you to resubmit the protocol for review by the Committee.

Traci Craig