THE EFFECTS OF NATIONAL AERONAUTICS AND SPACE ADMINISTRATION DEVELOPED EDUCATIONAL MATERIALS ON STUDENT ATTITUDES TOWARD SCIENCE

by

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Abstract

This study examined the attitudes that students, in the secondary or middle school grades, have toward science and what effects using National Aeronautics and Space Administration (NASA) developed educational materials have on these 6th, 7th, and 8th graders. Thirty middle school–aged students from different areas of the United States enrolled in a summer residential camp-like program were the subjects of this study. This summer program used educational materials and resources provided by NASA to support the theme of the organization, aerospace, rocketry, and space exploration. Qualitative data through face-to-face interview responses and journal writing samples provided an insight into the responses of the quantitative survey of Test of Science Related Attitudes (TOSRA). This pencil-and-paper preintervention survey was given prior to students beginning the NASA educational program. The intervention, which included activities that surround aerospace, rocketry, and space exploration, took place over a weeklong period. This intervention was guided by the educational materials designed by NASA. Throughout the experience, students were encouraged to maintain a daily journal for this researcher to compare the qualitative data with the quantitative data of the TOSRA. After the intervention, a select number of participants were made available for a face-to-face interview to gain a perspective into experience as related to the research questions. To determine if the intervention was the catalyst for change, the preintervention survey data were compared with the postintervention survey data, analysis from the interview transcripts, and analysis of the journal entries. This study provides evidence to assist in a continual evaluation of various curriculums that support a change in middle school–aged

student attitudes toward science. Moreover, these results support placing high value of student attitudes when designing curriculum.

Dedication

This dissertation is dedicated to people who work in the National Aeronautics and Space Administration educational community who take complicated data generated on a daily basis and disseminate it to schools all over the world in an easyto-understand format. Included are the astronauts who risked their lives to bring educational experiences back from space and continue to inspire young students today. This dissertation is also dedicated to those teachers who use this material to inspire their students to look up at the stars to envision their position in the future of space exploration while helping their students understand the concepts of science, technology, engineering, arts, and math.

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CHAPTER 1. INTRODUCTION

Introduction to the Problem

Regardless of where one comes from, where one lives, or where one is going, science plays an intricate part in just about every aspect of life. Advances in science are bringing technological advances that only years ago were fantasies. Products such as the alarm clock woken up to each morning can be programed to have different ringtones or music. The morning or evening shower may be self-heating and energy efficient. The cars driven to work may be propelled with both battery and fossil fuel power. Cell phones now have the ability to power down electrical system throughout an entire home. All these tasks were developed through the knowledge of science.

Discussions about science have often turned into political debates over many controversial issues that hold the key to the future on earth. Global warming, vaccinations, and the rise of new diseases are just a few of the issues future societies will be confronted with. Earth's people and politicians are still at odds over the morality of cloning, genetic engineering, animal rights, and whether man is responsible for the premature species extinction. Also included in the list of science related controversies is over population of the planet, the raping of our natural resources and the right to determine the timing and means of one's own death (Leonard, 2010). The future may rely on the understanding of science so decisions can be made for the best of humans on Earth and elsewhere.

Despite the fact that science drives many behaviors, actions, and thoughts as a society, it may appear that it is not given a high value. Studies report that the general public does not necessarily have the same positive feelings toward science and scientists as they do with high ranking politicians, lawyers, CEO's of big business companies and civic leaders (Movahedzadeh, 2011). Policy makers and scientists appear to have different goals, and attitudes toward information. They sometimes disagree on language, timelines, and even career paths. With the future of Earth and its inhabitants at stake, it should be important that issues that divide men of science be negotiated to meet at common ground (Choi, 2005). Evidence that science benefits mankind is overwhelming and it should be embraced for the sake of the future.

Workers and researchers in the fields of science, technology, engineering, and math (STEM) bring to the world new inventions, new technologies, innovations, creative problem solving, new companies, and industries. However, business leaders in the United States and around the world have shared their concerns over the number of available STEM related workers. STEM related jobs numbers have grown at a rate of three times compared to non-STEM related jobs (U.S. Department of Commerce, Economics and Statistics Administration, 2011). Compared to STEM workers, nonSTEM workers are more likely to experience unemployment in their perspective fields. STEM workers have been credited for the stability and growth of the United States economy and will play a key role in helping the future economy of the United States (U.S. Department of Commerce, Economics and Statistics Administration, 2011).

International comparisons show that the United States is trailing other countries when it comes to STEM education. In the global sense, the United States lies somewhere in the middle of the list of countries that monitor students' progress in math and science. In science, the United States falls is ranked number 22 compared to other nations, falling from 18th in 2009. Scores were higher than the other tested 29 nations and about the same as 13 others (Fensterwald, 2013). As more STEM qualified workers in the United States will be needed in the future, talented employees may need to be recruited from other countries.

Perhaps the lack of achievement could be a result of student's attitudes toward science in secondary schools. Several studies conducted in developing countries have indicated that both the interest and the attitude toward science decline during the secondary years of education (Jenkins & Pell, 2006; Lindahl, 2003; Osborne, Simon, & Collins, 2003). One of the strongest contributors to this decline is the lack of relevance in their lives (Aikenhead, 1996; Leach, 2002; Osborne & Collins, 2000; Reiss, 2000; Tytler, 2007). For many schools, the curricula are bogged down with facts to be learned and "with insufficient indication of any overarching coherence and lack of contextual relevance to the future needs of young people" (Millar & Osborne, 1998, p. 3), which leaves little time for students to reflect and build on their scientific understanding and cope with science in their daily lives (Goodrum, Hackling, & Rennie, 2001; Murray & Reiss, 2005).

For a long time, students in the secondary school educational setting have merely tolerated science. Regrettably, the basic science curriculum in many schools consist of lectures and facts about scientific theory and what science has discovered, along with the painful task of memorizing the long list of alien words that come with the field of the different fields science (Marincola, 2006). With more pressure being placed on students from high-stakes testing, they may not have the time to explore the subjects or even use them in their daily lives.

Believing that one is successful in science may have a positive impact towards ones attitudes toward and interest in science. The opposite may hold true. Research shows that student attitude has a direct effect of their participation (Braten & Stromso, 2006). Findings by the National Science Foundation indicated that female students are less likely to pursue a career in the science fields (National Science Foundation, Division of Science Resources Statistics, 2003). Male students are more encouraged to have a more positive attitude toward science throughout their childhood lives. As children, playtime for boys' recreation revolves around scientific development, understanding, and inquiry (Knight, Hebl, & Mendoza, 2004). Toys, such as those that help develop skills involving building and construction, foster engagement in the fields of science at an early age (Desouza & Czerniak, 2002). Toys for girls usually are not designed to cultivate engagement and inquiry. The attitudes related to science start at childhood.

In many cases, the term, *science attitudes*, is broadly used when discussing science education and is often interchanged with various context. Science attitudes can be categorized into two groups. The first is the attitude toward science (e.g., attitude toward social responsibility in science, attitude toward scientists, and overall interest in science). The second group is the scientific attitude, which covers but does not limit the skepticism, honesty, and having an open mind toward science.

Few studies have been conducted on attitudes and science learning. Factors that have contributed to high student achievement includes classroom environment, a variety of teaching methods and student attitudes. When the teacher maintains the proper classroom learning environment and uses a variety of innovative teaching strategies, research has shown that a relationship is formed between high student achievement in science and a positive attitude (French & Russell, 2006). Studies have also indicated that a positive attitude toward science and scientists can influence views of science, future career awareness, and classroom participation. Jarvis and Pell (2005) found that students with positive attitudes toward science show more attention to instruction within the classroom and are more likely to participate in science activities. If learning attitudes are improved, perhaps student achievement will be as well.

Literature suggests that as a student begins to leave elementary school, or about the age of 10, their interest in science is shown to be high and with little differences in a gender gap (Murphy & Beggs, 2005; Pell & Jarvis, 2001) or aptitude (Hawortha et al., 2008). However, from the many studies conducted over the past decade is the finding that, by the age of 14, the majority of students have already formed the position of whether to pursue further studies in science (J. F. Osborn, Ratcliffe, Collins, Millar, & Duschl, 2003) This would indicate that by the time students enter middle school, their opinions and interest in science are already formed.

For the best interest of society and the responsibility of educators rise the level of students attitudes towards science prepare them to live in a highly scientific and technological world. It has been suggested the future of mankind and society will be driven by those who have a complete understanding of science and technology. It is they who will influence the path into the future and how it will affect the world (Ungar, 2010).

Background, Context, and Theoretical Framework

In August of 1981, under the authority of 20 U.S.C. 1233a, the National Commission on Excellence in Education was governed to review, compile and compare data on the quality of learning in the nation's schools, colleges, and universities. Special attention was paid to educational experiences of teenagers and other youth (U.S. Department of Education, 1983). In a report titled A Nation at Risk (U.S. Department of Education, 1983), it was concluded that the United States displayed many areas of concerns such as high rates of illiteracy, low test scores in math and science, and a high lack of writing skills. Soon there became a movement toward standards-based education and assessing student achievement (Jorgensen & Hoffmann, 2003).

In 1994, the Improving America's Schools Act of 1994 was passed and later, the Elementary and Secondary Education Act of 1965 was reauthorized to focus efforts on funding poor schools with low-achieving students. Called Title I, its goal was to improve education in low socioeconomic areas and raise academic achievement of millions of disadvantage children. Also, the redesigned Elementary and Secondary Education Act encouraged all states and school districts reform programs to join with the federal government programs connect federal programs that would affect all children paying particular attention on special needs students (Social Welfare History Project, 2016).

That same year, the Goals 2000: Educate America Act became law, which for the first time focused on the needs of all students in education. The premise was that if all children are to learn, then the entire school had the responsibility to be focus on the learning for all children. The act also allowed states to have more voice in the education process by giving them the power to design and operate their own federally funded education programs and give local districts the authority to set challenging content and performance standards that will bring about higher student achievement (U.S. Department of Education, 1998).

In January 2002, President George W. Bush signed into law the No Child Left Behind Act of 2001 that provided a cornerstone of the nation's educational system. Accountability, local control, parental involvement, and funding what works were the elements of the No Child Left Behind Act (No Child Left Behind. 2001).

In the mid-1990s, a push for inquiry-based learning became the focal point of the National Science Education Standards. Also, the National Council of Teachers of Mathematics went to work outlining their K–12 standards focusing on math understanding, knowledge, and skills and the International Technology and Engineering Educators Association compiled valuable Standards for Technological Literacy (Woodruff, 2013). The recommendations from all these organizations came together to produce a model that will assure that students will be ready for future careers in STEM.

Since then, many other educational organizations have joined the cause. In the late 1990s, the National Science Foundation combined the disciplines of science, technology, engineering, and math and coined the acronym STEM. According to the National Science Foundation, this acronym consolidates the requisites of the subject areas necessary to achieve student success. STEM philosophy is an understanding that subjects cannot and should not be taught segregated from each other, just as there separation does not exist workforce (Woodruff, 2013). Today, the STEM model can be found in many secondary schools around the United States and is a common language throughout the educational arena.

Science and other subjects academic performance has been monitored by the National Assessment of Educational Progress, a congressionally mandated study since 1969. Student performance is measured two ways. Scale scores use a continuous scale to measure student learning. A range of zero to 300 is used as an assessment score for science in all grade levels. Achievement levels are assigned in conjunction with the scale scores by the National Assessment of Educational Progress reports. Achievement levels measure the differences in what the student achieved versus the achievement expected of them. This rating scale was developed by the National Assessment Governing Board. In 2011, tested eighth graders average scale scores climbed from 150 in 2009 to 152 (National Center for Education Statistics, 2016). Like scale scores, the percentage of eighth graders achieving at or above the proficient level in science also climbed from 30% in 2009 to 32% in 2011. Although this increase in both the achievement levels and scale scores showed improvement, the majority of students are still performing below the proficient levels in both 2009 and 2011 (National Center for Educational Progress, 2012).

Comparing the achievement levels in science and math of the United States and those of other countries requires other measuring tools. The Trends in International Mathematics and Science Study (TIMSS) is a tool used by a group of participating educational institutions to test students' knowledge on science and math topics related to the common curriculum. Two dimensions were assessed under the framework. Under the content domain, math and science concepts are assessed. The assessment framework included two dimensions: a content domain for the subject matter to be assessed within mathematics and science, and a cognitive domain for the skills (e.g., knowing, applying, and reasoning) expected of students as they learn the mathematics or science content. In

2011, the average science scores of both U.S. fourth- and eighth-grade students (544 and 525, respectively) were higher than the international TIMSS scale average (500; Provasnik et al., 2012). In 2011, students in grade four were outscored by seven countries (Japan, Singapore, Russian Federation, Republic of Korea, Finland and Taipei) out of the 50 countries that participated in the TIMSS with scores of 552-587 versus 544 (Provasnik et al., 2012). Out of the same 50 participants, the United States scored lower than eight of those countries (552−587 versus 544). At Grade 8, the U.S. average science score of 525 was lower than eight countries/jurisdictions yet higher than those of 29. Out of the 17 countries fourth graders that participated in the TIMSS testing in 1995 and 2011, three outperformed the United States in 2011 were in 1995 two outscored American students. Six countries eighth grade students scored higher than the United States in both years of testing (Provasnik et al., 2012).

The Program for International Student Assessment (PISA), in contrast, was designed to assess the abilities of 15-year-olds to apply mathematics and science skills and information to solve real problems they may face at work or in daily life. The PISA is an international assessment that measures 15-year-old students' reading, mathematics, and science literacy every 3 years. The PISA also includes measures of general or crosscurricular competencies, such as collaborative problem solving. It emphasizes functional skills that students have acquired as they near the end of compulsory schooling. PISA is coordinated by the Organization for Economic Co-operation and Development, an intergovernmental organization of industrialized countries, and is conducted in the United States by the National Center for Education Statistics (Institute of Education Sciences, n.d.). These data show that the out of the six proficiency levels in science, the United States is average in the below Level 2 in science (18%) compared to all other countries and just shy of the average of 8% of the countries that participate. Based on the 2012 Program for International Assessments twenty-six countries beat out the United States for those students who are most proficient in science (Desilver, 2017).

A concern expressed by many countries is the failing number of students choosing to pursue the study of science, along with the increasing recognition of the importance and economic utility of scientific knowledge (Barmby, Kind, & Jones, 2008). This situation called for researchers to find the underlying causes and mechanisms to the problem and to find ways to improve it.

Unemployment is on the rise across Europe but in STEM fields, the real problem is a shortage of skilled talent. According to The Observatory on Borderless Education (2013), Germany alone was short 114,000 STEM-skilled workers in 2011 (The Observatory on Borderless Higher Education, 2013). According to a 2011 report by Business Europe, a lobbying group representing national business organizations, interest in undertaking STEM studies is dropping in many European Union countries, and the share of STEM graduates fell in relation to the total number of graduates from 24.8% in 1999 to 22.7% in 2005 (The Observatory on Borderless Higher Education, 2013).

When comparing the U.S. position in STEM studies with other countries, the Organization for Economic Co-operation and Development found the United States 34th in its ranking (Kärkkäinen & Vincent-Lancrin, 2013). In order to remain globally competitive, the United States must take advantage of the talents of all of the workforce. Without increasing the numbers of students going into STEM fields, the number of engineers and other STEM professionals will continue to decrease (National Math + Science Initiative, n.d.).

The investigation of students' attitudes toward studying science has been a substantive feature of the work on the minds of science education research community for the past 30–40 years (Sarjou, 2012). Many have been concerned about the low numbers of college students pursuing both majors in science and STEM careers (Sunstein, 2013). Science college majors have the potential to contribute to economic growth and can end up in especially good jobs with high pay. These low numbers have contributed to what is now being called the *STEM crisis* (Sunstein, 2013).

In 2015 Bidwell reported, "Despite the intense drive to encourage students to study science, interest levels fell between 2009 and 2013 and are now just slightly below where they were in 2000" (Bidwell, A. 2015). This has brought into question the future supply of qualified persons for physics teachers for schools and colleges. Finding a definitive understanding into underlying mechanism may lead to an improvement.

It has been noted that African Americans, Hispanic Americans, and American Indians are less likely to pursue careers in science than those in the Asian and European demographics (Center for Public Education, 2012). As reported, however, African Americans, Hispanic Americans, and American Indians make up 13.1%, 16.6% and 0.8% respectively of the U.S. working-age population but only make up 5.8%, 5.2%, and 0.4% respectively of U.S. scientists and engineers (National Science Foundation, Division of Science Resource Statistics, 2007). Experts have suggested that attrition of many minority groups away from science studies and careers begins in middle school grades (National Science Foundation, Division of Science Resource Statistics, 2007) as inequitable access to the kinds of instructional opportunities necessary for success in science may cause science achievement and attitudes toward science to decline (Liaghatdar, Soltani, & Abedi, 2011).

Many researchers have conducted statistical studies on the correlations between student attitudes and gender, ethnicity, ability, and other factors relating to science achievement. “Emerging from a growing body of research in the past decade is the finding that, by age 14, for a majority of students, interest or not in pursuing further study of science has been largely formed” (Murphy & Beggs, 2005, p. 257). Students’ attitudes toward science during middle school eventually leading them away from science careers which makes sense as a lack of interest in the subject may lead a student to choose not to take the science courses that can lead to science-related careers (Kanter & Konstantopoulos, 2010). A reduction in their science achievement levels may also be a contributing factor. Kanter and Konstantopoulos (2010) hypothesized that certain racial and social groups in middle school may be impacted in their choices to choose a future in the science field based on the attitudes and achievements.

Attitudes are “psychological tendenc[ies] that [are] expressed by evaluating a particular entity with some degree of favor or disfavor” (Eagly & Chaiken, 1993, p. 1). Attitudes are sometimes formed early in life and often the result of experience or upbringing. It can be manifested from the results of experiencing a particular object, person, thing, or event. It can have a strong influence on one’s emotions, beliefs, cognition intentions and behaviors (Cherry, 2016). In the point of view of Osborne et al. (2003), a student attitude towards enrolling in a course is a strong determinate of a student’s choice in pursuing future careers. As a result, a better understanding of student attitude and the relationship between course choice and future career choice would lead to instructional and curricular changes that may support and enhance students' learning of difficult subjects such as science, technology, engineering and mathematics.

Two types of attitudes exist in psychology. Explicit attitudes are those that can be consciously controlled and implicit attitudes are those that people do not have conscious access and the activation of those emotions cannot be controlled. It is hypothesized that "explicit attitudes form and change through the use of fast-learning, rule-based reasoning, whereas implicit attitudes form and change through the use of slow-learning, associative reasoning" (Sloman, 1996, p. 119). This study involves the changing of explicit attitudes through an intervention of introducing NASA-designed educational material to students who have been exposed to traditional pedagogy.

Attitudes may change when the factors are within the person. Festinger (1957/1967) identified this as the theory of cognitive dissonance. The foundation of this theory is the idea that when two cognitions are inconsistent, we seek ways to make the belief and the attitude consistent. There are three ways that an attitude can be changed or reduce the dissonance. First, two conflicting attitudes, behaviors or beliefs can be changed if the individual changes one or more of the elements. When an individual acquires new information, dissonance is reduced because the new information outweighs the dissonance belief. The last is to reduce the importance of the cognitions (i.e., attitudes, beliefs; McLeod, 2014a).

Attitudes and science anxiety are strongly linked (Beyer, Blegaa, Olsen, Reich, & Vedelsby, 1988; Mallow, 1993, 1995, 1998). Those personal experiences that produce the science anxiety affect the attitudes. Theoretical models in social psychology suggests that attitudes manifest themselves in three ways. Emotional, behavioral and cognitive responses (Breckler, 1984).

Positive attitudes toward any subject are frequently found to enhance students' interest and motivation to learn (Kara, 2009). Researchers of learning factors admit that they have been successful in identifying the issues that imped learning but also concede that have no concrete solutions (Osborne et al., 2003). One hypothesis presented is that there is a connection between learning science and motivational issues of the student that prevent learning (Akyürek & Afacan, 2013). Osborne and Collins (2000) pointed out that students crave more opportunities like hands-on practical work, a chance to do investigations and opportunities for talk about the material to each other through discussion—all of which provide an enhanced role for personal responsibility. To be successful as a learner of science, the learner must display a positive attitude as demonstrated by enthusiasm, a confident persona, with no episodes of anxiety about learning. Because the attitudes one has toward learning inevitably influence the outcomes, the more positive attitudes one has, the better one performs in learning (Braten & Stromso, 2006; Duarte, 2007). This research study introduced educational materials developed by NASA to determine if these materials can motivate and transform the attitudes of middle school–aged students.

Researchers have indicated the constructivism learning theories and many of its subsets are saturated in the modern ways of secondary school science learning. Included are the theories of, cognitive development, social cognitive learning and scaffolding, discovery learning (Glancy & Moore, 2013). These theories have been suggested as the driving force that many science-focused institutions use to develop their curriculum.

The foundation of the theory of constructivism has established that people develop their own understanding of the natural world through personal experiences and reflecting on these experiences (Concept to Classroom, n.d.). Many researchers and science educators share the idea that knowledge is gained by the learner and not transmitted from the teacher to the student (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Linn & Eylon, 2006; Schunk, 2008). It is the student that decides what was once believed or conclude that the new information is irrelevant. In both cases, the constructivism theorist suggests that the individual has now become the creator of their own knowledge. The constructivist classroom has been described as involving students in solving real-world problems through experimentation and reflection. By gathering students around a lab table to dissect a frog or mix chemicals, teachers are advocating the use of the constructivism theory. The teacher is seen more as a facilitator—a guide and not the distributor of information. Research has indicated that students in a constructivist classroom become expert learners as they gain understanding through constant assessment of the activities (Concept to Classroom, n.d.).

Under the umbrella of the constructivist learning theory lies the discovery learning theory. This type of educational theory revolves around the acts of discovery to rearrange and transform what is learned (McCleod, 2012). Hands-on experimentation can be helpful in bringing the discovery learning theory to life.

Social learning theories were developed by Lev Vygotsky, a Russian teacher and psychologist, to help students learn in the social context. He suggested that learning cannot be separated from the social context; therefore, students become expert by interacting with their peers. Vygotsky's research has indicated that teachers should create a learning environment that maximizes the interaction through discussion, collaboration and feedback as well as manage the dialogue that fosters deeper learning and understanding. Also noted, students should work together across the curriculum, on tasks that are challenging and meaningful (Vygotsky, 1978). Collaborative learning is seen in many school disciplines today. NASA materials are based on social interactions of students, a learning environment that encourages discussion, and interaction with real-life application, which qualifies as a practice in social learning theory (NASA, 2015a).

Another element of the constructionist learning theory is the contextual learning theory that was first proposed by John Dewey in the early 20th century. Contextual learning occurs when the facilitator introduces a subject that is related to real-world events. An example would be the study of hurricanes while a hurricane is near or approaching the residential area of the student. Strategies encourage the student to learn in a variety of contexts such as home, work, or community. Activities rooted in this theory target areas of cooperative problem solving and developing the skills to become self-directed learners (Hiemstra, 2006)

NASA incorporates subsets of the constructionist theories into its educational materials. STEM-based engagement activities are designed to connect the learner with unique missions and resources through participatory and experiential learning activities (NASA, 2015b). Within NASA's materials are elements of discovery, problem solving, and cooperative learning. As students' progress through the materials, they do so in teams to research and complete tasks, test theories, and develop satisfactory and effective solutions to the challenges. Learning now becomes relevant as they recognize the link between their lesson and the learning objectives (Rockland et al., 2010). NASA also uses a model of inquiry-based learning within their materials. Through the scientific inquiry process students are taught to think like a scientist through critical thinking and reasoning as they conduct research, test ideas and discover new concepts (Rockland et al., 2010).

Statement of the Problem

Contextual learning plays a valuable part in the attitudes toward students' academic success (National Research Council, 2003). Academic competence and high student achievement is reached when a balance between the student, the teacher and the learning climate has been met. Similarly, relationships between students and teachers and the climate in the classroom are positively associated with levels of student engagement and academic competence. There is a strong likelihood that they will learn something new and retain what they learned if both the material and the classroom environment is presented in a meaningful, challenging, and engaging way (Williams, 2002).

In 2012, it was reported that the United States scored lower than six other nations who participated in the international TIMSS test (Provasnik et al., 2012). On the PISA, 26 countries scored higher than the United States on proficiency in science (Institute of Education Sciences, n.d.). When compared with other countries in STEM studies, the United States ranked 34th (Kärkkäinen & Vincent-Lancrin, 2013).

An international assessment of 9- and 13-year-old students in 20 countries (International Assessment of Educational Progress, 1992) revealed that positive attitudes toward science influence student performance. Student interest in science at age 10 has shown to be higher (Murphy & Beggs, 2005; Pell & Jarvis, 2001) but at the age of 14, for the majority of students, interest or not in pursuing further study of science has largely been formed (Osborne et al., 2003). Based on some modern statistical data, middle or secondary schools may hold the key to future academic success in science and for a new trend in graduates pursuing the science fields.

Purpose of the Study

Because of the new trend introducing STEM education and the evidence that points to the stagnation in student achievement scores throughout the United States and the world, the purpose of this study was to introduce the many STEM concepts being taught in middle school using materials developed and designed by NASA in order to improve student attitudes toward science. Because NASA uses a wide range of strategies within its pedagogy, this study focused on the thematic context of the material and not the methodology.

Research Questions

The primary research question that drove this study is: To what extent does the use of NASA-designed educational materials improve secondary students' attitudes towards science?

The following additional research questions helped guide the study:

1. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the areas of social benefits, positives, and negatives on scientific progress and scientific research?
2. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the way scientists are perceived?
3. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students as to the way they see the scientific

method of inquiry as a valid way of thinking and that approaching a problem or situation?

4. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward scientific curiosity and openness to scientific interpretation?

5. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the enjoyment of science?

6. To what extent does the use of NASA-designed educational materials improve middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom?

7. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward pursuing a career in science?

8. How will using NASA-designed educational materials improve student attitudes toward the learning of science?

Rationale, Relevance, and Significance

The rationale for this study was based on an existing problem that must be resolved, previous research, and learning theory. It is in the secondary school arena in which a student will make a choice of pursuing a future in science or not (Jenkins & Pell, 2006; Lindahl, 2003; Osborne et al., 2003). There is no time in class for students to reflect on their studies and build a comprehensive understanding of science concepts and how they relate to the student (Goodrum et al., 2001; Murray & Reiss, 2005). Too many students' science class experiences have been note taking, lecturing, and memorizing words (Marincola, 2006). Pedulla (2010) suggested that achievement and/or student perceived ability in science may be related to their interest and attitude toward science education.

The National Aeronautics and Space Administration (NASA) provides educational materials to teachers and schools that are rich in STEM engagement. The activities provided by NASA are designed for participatory learning, connecting the learner to NASA unique resources. These are based on best practices in relevance, engagement, motivation, experiential learning, and STEM challenges (NASA, 2015a).

STEM challenges are embedded that challenge a student's existing assumptions that encourage innovation, critical thinking, and problem-solving skills. Many of the educational materials developed by NASA are mission related. Relevance is introduced by the high publicity that these NASA space missions generate.

NASA does not have a coherent plan to evaluate their programs efficiency. Few of NASA's projects have been evaluated and none have gone through a rigorous evaluation (NASA, 2015a). Therefore, there is little data or conclusions on which to base the effectiveness of the programs they produce. The information gained through this research study will add to the knowledge base concerning the effectiveness of the educational materials, provided by NASA, on improving students' attitudes toward science.

As a science teacher in a secondary school setting, this research has high value to both my students as independent learners and potential candidates for entering potential a STEM field in the near future. Science is going to play a major part in their lives as the world progresses toward dangerous global warming levels, over population, the depletion of natural resources and other threats to humanity. NASA has already taken the lead in investigating these phenomena, so introducing these complex issues through NASA educational materials will bring about a connection of relevance to the students, which is a key to student learning. Students currently in secondary or middle school are at the cusp of choosing a science career or turning their backs on one. With NASA's reputation of inspiring young people with dreams of space travel and other adventures, an introduction to NASA's research has the potential of turning students on to the science fields.

The significance of this study is highly beneficial on many levels. First, it sought to bring researchers one step closer to the solution of closing an achievement gap between low-achieving students and high-performing students in which efficacy is the issue. It is hoped that where poor student attitudes and low standardized test scores are prevalent, this study might bring about a better understanding of how educators can address these issues. Researchers can reference this study to expand their knowledge of curriculum versus attitude improvement.

As a result of this study, teachers can use the tools presented to evaluate how to use the different programs NASA offers. NASA might also use data from this study to determine the effectiveness of the materials they promote in their education efforts. This study examined the attitudes of students who were exposed to NASA-designed and NASA-developed educational materials.

As many schools and educational institutions struggle to increase overall science scores and look for ways to overcome student efficacy, the results of this study may contribute to the literature on improving science achievement. School districts and policy makers could use the evidence to support thematic lessons in the classroom and visualize the benefits project-based learning can provide. School leaders and educators could engage in additional studies and add to the knowledge base. If secondary school students have become more highly engaged, and motivated during this study by using the exciting educational activities provided by NASA, perhaps students will maintain a positive attitude toward science longer than the 14-year limit many studies have suggested.

Nature of the Study

Both a qualitative and a quantitative approach were used for this study. Many things were not known about the study participants such as their backgrounds, experiences and perspectives. The participants came from diverse social economic, different academic backgrounds and were schooled in science using different pedagogy. Qualitative data were gathered through the analysis of journal writing samples and personal interviews. To gather quantitative data, a field-tested pretest and posttest survey was used.

The data were gathered from 30 students ages 11–14 who were participating in a residential summer camp environment. This program specialized in promoting science, technology, engineering, arts, and math activities and was directly tied into a NASA facility in which the students could participate in real-world applications of the learned concepts. Prior to their participation, a precamp survey was given to determine the current status of their attitudes toward science. Every evening they were asked to write in a journal their experiences, likes, dislikes, and level of participation. After the camp, the Test of Science Related Attitudes was administered, a randomly selected number of students were chosen to participate in a short interview. At the end of the week, all participants completed the posttest survey.

Definition of Terms

National Aeronautics and Space Administration (NASA). An independent agency of the executive branch of the U.S. federal government responsible for the civilian space program as well as aeronautics and aerospace research.

Project-based learning. A student-centered pedagogy that involves a dynamic classroom approach in which students acquire a deeper knowledge through active exploration of real-world challenges and problems. Students learn about a subject by working for an extended period of time to investigate and respond to a complex question, challenge, or problem.

Science, technology, engineering, and math (STEM). An education grouping used worldwide. STEM refers to the academic disciplines of science, technology, engineering, and mathematics. The term is typically used when addressing education policy and curriculum choices in schools to improve competitiveness in science and technology development.

Test Of Science Related Attitudes (TOSRA). An instrument created by Fraser (1981) that quantitatively measures the seven manifestations that make the attitudes of students toward science. The manifestations include Social Implications of Science,

Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes,

Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. The TOSRA is used by researchers, teachers, and curriculum evaluators to monitor student progress toward achieving attitudinal aims (Fraser, 1981).

Assumptions, Limitations, and Delimitations

This researcher made many assumptions that puts the research in context. By their content and design, NASA-developed educational materials that address those factors that have research-based evidence to improve student attitudes in learning science. Studies suggest that if a science program contains (a) a positive interaction between teachers and students, (b) means for allowing students to feel successful performing particular tasks, (c) and challenging curriculum, and leads students to see science as important, helpful, and useful for future life, attitudes of students toward science will improve (Agranovich & Assaraf, 2013).

Assumptions based on the study included

- The summer program group demographics represent the demographics of the school's district population in which I reside.
- National Aeronautics and Space Administration has been associated with bringing excitement, inspiration, interest, and engagement in science (National Research Council, 2008).
- The Test Of Science Related Attitudes has a direct correlation to the research questions to be answered (Fraser, 1981).

Organization of the Remainder of the Study

In Chapter, 1 the study was introduced and the context of how the research is interrelated to the problem in terms of the background and the theoretical framework was discussed. Chapter 2 dives deeper into the study by focusing on the theoretical framework associated with the problem. Scholarly literature is analyzed, synthesized, and critiqued as it relates to the problem described in Chapter 1. Chapter 3 addresses the methodology selected to mitigate the problem, and to answer the research question, Chapter 4 presents the analytical data ascertained. In Chapter 5, the conclusion of the dissertation and a summary of the findings are included. A conclusion is drawn from the collected data, and analysis and the relationship between the findings and the literature and the recommendations for best practices and future research are discussed.

CHAPTER 2. LITERATURE REVIEW

Introduction to the Literature Review

The purpose of this study was to evaluate the effect of using National Aeronautics and Space Administration (NASA) developed and designed educational materials on the attitudes of secondary school students learning science. A review of current literature related to the topic and underlying theories of this study was conducted. Also included, was a review of research methodology as it related to science instruction, and the relationship between attitude and accomplishment. A comprehensive search for information on similar research studies, related educational theories and strategies on science instruction, and relevant discussions on this topic was performed. Recent journal articles, books, and professional Internet databases related to this topic were used during this literature review process.

Theoretical Framework

A review of the literature revealed many theories explaining how instructional strategies can affect student attitudes toward science learning. One of these theories, constructivism, has provided an effective model on which the learning of science can be based. Research studies indicated positive correlations between achievement in science courses and positive attitudes toward learning science. Certain characteristics of the classroom environments that include personal support, use of a variety of teaching strategies, innovative learning activities, and student-centered instructional designs have all been reported in recent research journals (French & Russell, 2006; Osborne et al., 2003). The "What Is Happening in the Class" study found comprehensive evidence to suggest that the classroom environment does influence how well students achieve in science learning (Frazer, Aldridge, & Adolphe, 2010).

Understanding the theoretical framework of science pedagogy and learning processes have important implications for both the teacher and the learner. This study was driven by the principles of some of the most influential learning theories and built on a foundation of constructionist views. Three researchers of human learning are imbedded in this study. Jean Piaget and Lev Vygotsky each contributing to the relationship between the intervention and cognitive development in the science learning context. John Dewey is also credited with progressive science education in the United States. Although the reviews of science education methodology have been performed many years ago, many find that Dewey should be highly credited for introducing practices that involve critical thinking and problem solving (Champagne & Klopfer, 2006).

The theoretical implications of this study could possibly change how the management thinks about learning science. Components of a good science class include hands-on inquiry activities and thus should play a part in influencing student attitudes (Osborne et al., 2003). In a real sense, learning cannot occur in classrooms in which science is not seen as fun, useful, and intriguing. It was believed that the results of this study could possibly influence management's philosophy, which would allow for teachers and students to become more successful.

Constructivist Theory

Constructivist instruction is an educational model that believes the centerpiece of learning revolves around the learner themselves and not the instructor who disseminates information for the learner to absorb. In constructivism paradigm, learning is a continuous journey of searching for meanings through an understanding of concepts and contextualizations instead of focusing on isolated facts and figures. Throughout the process, knowledge is created via a link to previous knowledge. Constructivism involves the student's social interactions with peers and the instructor, individual learning style, and learning capabilities ("Education Theory," n.d.).

The concept of constructivism has roots going back to Socrates's dialogues with his followers, in which he asked directed questions that led his students to realize for themselves the weaknesses in their thinking. The Socratic dialogue is still an important tool in the way constructivist educators assess their students' learning and plan new learning experiences. Socrates is not generally associated with constructivist philosophy; nonetheless, this anecdote highlights the fact that discussions linking epistemology and learning have been taking place for thousands of years. From the perspective of psychology, epistemology considers the genesis and the nature of knowledge and learning (Ernest, 1995). Knowledge, its nature, and how one comes to know are essential considerations for constructivists. Von Glasersfeld (1995) described constructivism as a "theory of knowledge with roots in philosophy, psychology and cybernetics" (p. 162). In the constructivist perspective, knowledge is constructed by individuals through their interactions with the environment.

The term *constructionism* refers to the idea that the learner or learners construct knowledge for themselves. For Piaget (1978), adults' and children's cognition and behavior are guided by past experiences. New cognitions and behaviors are based on the relationship to existing experiences (Piaget, 1978). For new knowledge to assimilate, it must fit into existing schemes. When a learner encounters a situation in which the past experiences cannot explain the new information, the existing schemes must be changed or new ones made. Piaget called this accommodation. The condition leading to accommodation is known as disequilibration—that is, the state encountered by a learner in which new information does not fit an existing scheme (Slavin, 1988, p. 194). To balance out the cognitive system, new schemes are developed or old ones are modified until the balance is reached. Only then can the new information be accommodated into the learner's perspective or views.

The psychological roots of constructivism began with the developmental work of Jean Piaget (1896–1980), who developed a theory (the theory of genetic epistemology) that analogized the development of the mind to evolutionary biological development and highlighted the adaptive function of cognition. Piaget proposed four stages in human development: the sensorimotor stage, preoperational stage, concrete operational stage, and formal operational stage. In the sensorimotor stage, from birth to age 2, a child's cognitive system focuses on motor skills that become more sophisticated as the child develops (McLeod, 2014b). In Stage 2, called the preoperational stage, from ages 2 to 7 years, children acquire representational skills through imagination, language, and the way they view the world from their own perspective (McLeod, 2014b). In Stage 3, the concrete operational stage, which lasts from ages 7 to 12, the child is capable of taking another's point of view and take into account more than one perspective simultaneously (McLeod, 2014b). Although they can understand concrete problems, they do not consider all of the logically possible outcomes. Lastly, the formal operations stage, which affects age 12 through adulthood, is when they become capable of thinking logically and abstractly (McLeod, 2014b). They can also reason theoretically. This study focused on the formal operations stage.

Constructivism is a theory that hypothesizes learning as active, contextualized, and constructive. Learners construct knowledge based on their own person experiences and create their own subjectivity or objective reality. They use social negotiation to create new knowledge, test their hypothesis and confirm previous learned knowledge (Khalid & Azeem, 2012). Constructivists argue that a learner does not start with a clean slate and builds knowledge through cultural factors and past experiences to construct new knowledge. They believe that the learner comes into the academic world with experiences, prior knowledge, skills and a perception of the surrounding environment. There are many factors that contribute to the classroom learning environment. These include the physical environment, classroom climate, psychological climate, the roll of the teacher, measuring the climate and initiatives and other considerations (Miller & Cunningham, n.d.). A positive physical environment that has cooperative grouping gives students a more positive perception of cohesion, fairness and support. The classroom climate and psychological climates both defines how the teacher interacts with students and how students interact with each other. The role of the teacher defines the teacher behavior, development and how the teacher and the schools culture affect the classroom. Measuring the classroom environment captures the high-inference constructs, and therefore better represent day-to-day experience in the environment. Lastly, the initiatives and considerations such as the environment outside of school, school-wide demands and increase use of classroom technology (Miller & Cunningham, n.d.).

Dewey (1916/2016) proposed that education should resemble realistic situations structured on vocation. As he stated, “the only adequate training for occupations is training through occupations” (p. 297). Instead, his use of the terms vocation or occupation referred to “a direction of life activities as renders them perceptibly significant to a person, because of the consequences they accomplish, and also useful to his associates” (p. 294). He viewed education as a model taken from outside school activities that are engaging and fulfilling in social and civic context while preparing students for continued growth needed in any career.

Project-based learning is grounded in the constructivist theory, which allows for many possibilities to transform classrooms into active learning environments. One of the requirements for constructivist theory is that learners are actively constructing knowledge through activities and the goal of learning is designed by teachers to promote a deep understanding rather than remote memorization. Constructivist thinking provides a foundation for project-based learning pedagogy as students collaborate with others, participate in comparative learning experiences and become reflective in the process (Jonassen & Grabowski, 2003). Knoll (1997) supported constructivist concepts and inquiry-based problem solving and design in U.S. fields of education. Knoll supported the idea that the project is one of the best and most appropriate ways of teaching. Howe and Stubbs’s (1997) view of the constructivist model emphasizes students’ understanding of world and application of previous knowledge to new situations.

Embedded in the NASA educational materials is the project-based learning theory. A spinoff of the constructionist theory, learning is the project-based philosophy in which the main emphasis is on learning through the construct of specific projects (Thomas, 2000). Students are using real-life problems to analyze in a natural setting and proceed to construct their own products that interpret into a possible solution. From this process, students acquire an understanding of the concept, gain self-confidence and display responsibility (Muniandy, 2000; R. Osborn & Freyberg, 1985; Villeneuve, 2000). The principal values in project-based learning are constructing knowledge through trial and error, learning by doing, and applying new knowledge to new circumstances (Colley, 2008; Singer, Marx, Krajcik, & Clay-Chambers, 2000; von Glasersfeld, 1995). Project-based learning is popular in modern-day science education pedagogy.

Both Richard Lesh and John Dewey agreed that it is important for students to make personal connections and experiences. In the NASA educational realm, situations are put into the hands of students making them the decision makers and shifting the activity from a no connection relationship with the learner to an individually and socially useful experience, or as Dewey (1916/2016) described, an “activity which renders service to others and engages personal powers in behalf of the accomplishment of results” (pp. 306307). Lesh et al. (2000) called this the reality principle, which states that “it is important for students to try to make sense of the situation based on extensions of their own personal knowledge and experiences” (p. 614). Real-world problems and situations can be complex as they relate to human dynamics, values and social implications. According to Lesh et al., the problems student must be challenged with should exhibit these same characteristics. Lesh et al. stated, “The key to satisfying the reality principle is not for the problem to be 'real' in an absolute sense" (p. 149). In order for subject integration to be successful, the situation is feasible and believable.

Discovery Learning Theory

Out of the constructionist theory come other learning theories. *Discovery learning* refers to the acquisition of knowledge for oneself (Bruner, 1961). Discovery learning is important to cognitive learning because it is all about developing, constructing, and testing hypothesis in comparison to reading textbooks or listening to lectures while taking notes. Inductive reasoning occurs as the student formulate general rules, concepts, principles, and conceptual theories. The instructor arranges the activity that the students are to manipulate, investigate, and explore while learners are allowed to do what they want as part of the problem-solving process (Klahr & Simon, 1999). Discovery learning has found a place in the educational materials NASA has developed.

NASA activities produce this type of learning environment. One example is the NASA Engineering Design Challenge: Thermal Protection Systems, in which students are challenged to design and build a heat protection system that will (simulated) protect astronauts from the high heat of reentry. Students are given specific materials as constraints for their challenge and instructed to use only these materials to design, build, test, and revise a successful system measured by a protection time of an unprotected model. On their own, students document their procedures and results (National Aeronautics and Space Administration, n.d.).

Science, Technology, Engineering, and Math

NASA incorporates the science, technology, engineering, and math (STEM) disciplines in their educational materials. STEM has a foundation in the theories of John

Dewey, Zoltan Dienes, and Richard Lesh. As STEM programs gain in popularity in the middle school setting, educators need to develop the pedagogy based on the complements of learning theory that exist. Dewey and Lesh believed that student success can be contributed to social learning and based on real-world application. Lesh noted that, outside of school, problems are solved by teams whose members come from different areas of expertise and experiences (Hamilton, Lesh, Lester, & Brilleslyper, 2008; Lesh, Hoover, Hole, Kelly, & Post, 2000). For this reason, logic dictates that teamwork be promoted to enhance communication skills and metacognition. Dienes also supported group learning to the point that the learner can also be a group (Sriraman & Lesh, 2007). Dewey, Lesh, and Dienes provided the theoretical underpinning to set up an effective learning environment through collaboration and integrated science, technology, engineering, and math disciplines that will set up students through the future.

Integration is an essential characteristic of a learning environment. STEM has a strong connection in local, state, and national education policy and still remains being taught as separate entities in classrooms (Glancy & Moore, 2013). However, in looking at the commonalities of these subjects, a shift in pedagogy introducing these disciplines together has gained in popularity (Bossé, Lee, Swinson, & Faulconer, 2010; EngrTEAMS, n.d.; Nyaumwe & Brown, 2010; Redmond et al., 2007; Wang, Moore, Roehrig, & Park, 2011). According to the U.S. Department of Education's 2015 Science, Technology, Engineering and Math: Education for Global Leadership,

> All young people should be prepared to think deeply and to think well so that they have the chance to become the innovators, educators, researchers, and leaders who can solve the most pressing challenges facing our nation and our world, both today and tomorrow. (para. 3)

For students who are learning these subjects in a segregated environment these disciplines have no meaning. This is especially true in middle school, in which teachers are facilitating specialized subjects unrelated to each other.

Theorist of the study of mathematics make the same claims as Dewey (1916/2016) made. Lesh and Zawojewski (2007) stated, explaining science, "The traditional topics serve as good descriptors of the work" (p. 781) but mask the fact that in realistic situations, the mathematics is "more complex, situated, and multidisciplinary than the conventional topic descriptions imply" (Glancy & Moore, 2013, p. 4). Dewey as well as Lesh and Zawojewski believed that if mathematics is taught separately in the classroom, students see no meaning or relationships (Glancy & Moore, 2013).

Thinking about student motivation when designing educational materials, although is important to learning, can no longer be the only factor educators must consider when deciding instructional pedagogy. Student attitudes also must be a valid factor. "A student's attitude toward a given course or subject area can be a contributing factor to his achievement in it" (Edwards & Porter, 1970, p. 107).

Attitudes can be defined as "internal beliefs that influence personal actions and that reflect characteristics such as generosity, honesty, and commitment to healthy living" (Abedlazeez, 2011, p. 12). Attitudes are inferred through many factors because they cannot be observed directly. It is believed that attitudes are learned indirectly through experiences and exposure to symbolic models such as television and other media (Gagné, 1984). Teacher can assemble a learning environment to improve intellectual and motor skills through change.

Just as teachers help society members to acquire knowledge to solve everyday problems and issues, students must strive to absorb the information presented with a positive attitude. A positive attitude toward any subject is needed to succeed in learning about it (Başaran, 1974). Characteristics of successful leaners are confidence, enthusiasm, a lack of anxiety, and positive expectations. Attitudes have been shown to have an influence on outcomes and the more positive the attitude, the better one performs in learning (Braten & Stromso, 2006; Duarte, 2007).

Consistency theories state that there must be a balance or consistency between an individual's attitude and behavior (Zimbardo & Leippe, 1991). To achieve this balance, an individual will change or modify one or both to achieve this homeostasis. When an object, person, or event does not correspond with an individual's belief, that person is inconsistent (Simonson & Maushak, 2001). The theory suggests that when new information is processed in an attentive and thought invoking method, a change will bring about harmony evident through acceptance and retention.

Practical implications include high student achievement in science. Positive attitude about science decrease between Grades 6 and 10 with the greatest drop between the beginning and middle of each school year (Lutz, 2011). Evidence suggests that attrition of students away from science and engineering careers begin in the middle grades (Lutz, 2011). Reduced achievement levels may result in students not being able to take sciences courses that lead to science careers (Kanter & Konstantopoulos, 2010). Several influences on the student learning include teachers, self-concept, parents, peers, achievement motivation, science anxiety, and gender (George, 2000). This study concluded that when self-concept is high, there are higher attitudes toward science.

Studies have shown that there indicates a strong relationship between student achievement, technology-rich environment, self-directed environment, and attitudes (Hsieh, Cho, Liu, & Schallert, 2008). In one study, "a positive change in the attitudes of the research group students towards science class" (Akinoglu & Tandogan, 2007, p. 77) occurred during an inquiry-based learning study. K. K. Perkins, Adams, Pollock, Finkelstein, and Weinman (2004) found that students who have more favorable attitudes are more likely to have higher achievement. A positive correlation between science attitudes and conceptual learning gains were noted.

Conducting the current study expanded the understanding of how using NASA thematic materials can change student attitudes toward science. It was hypothesized that improving attitudes toward the learning of science could improve student achievement, reduce science anxiety, improve motivation, enrich student understanding and use of technology, and help students become more self-directed learners.

Bloom (1976) suggested that learning can be attributed to only a few factors. These include students' attitude toward what they are learning or studying, the school environment, their self-concept, and the quality of the instruction (Bloom, 1976). Many of these factors like providing students with interesting and challenging coursework and a positive school environment can be manipulated by the teacher or the institution. Unfortunately, Bloom identified factors beyond control of teachers and schools, which include natural ability, previous learning, and home influences.

Attitude Theories

Students' attitudes, which include their interests and values, should be important to educators because these factors act as a powerful indicator of students' subsequent behavior (Popham, 2011). For example, if a student develops an interest in learning at a young age, he will most likely continue to maintain that attribute long after he left the academic world.

Research studies have identified many factors that influence attitudes toward science. Gender is the most significant variable related student attitudes toward science (Akay & Boz, 2010; Gardner, 1975). This can be explained by social media that portrait gender bias and ethnic stereotypes differences from television programs, commercials, and adults they see around them. Many young children see pictures and images of scientists, most of which are White men who display strange behaviors. During holidays, boys will receive gifts such as chemistry sets or telescopes whereas girls get dolls or other stereotypical presents.

Evidence through research studies claim that the longer students study typical school science the more negative the attitude becomes towards science, science classes and their science teacher (Akay & Boz, 2010; Yager & McCormack, 1989). If attitude effects student achievement in learning science, then exploring ways of improving the attitudes of students towards science in secondary schools should be a mission for improving student success. Other studies have shown that by transforming a student's attitude from negative to positive, an increase in participation occurs (Braten & Stromso, 2006). Visser (2008) found that students' who believe they are acquiring knowledge was another significant factor in the level in which they will perform. Those students who believed that they succeeding academically at a quicker pace than before has fewer problems searching for information. Karagiannopoulou and Christtodoulides (2005) showed that compared to a college entrance examination, the attitude of the candidate is more of a predictors of academic success. Factors that influence the views and perceptions of learning was researched by Bahn (2007). He found through the studying of 42 nurses the number one factor to improved learning is having a positive attitude.

Another study done by Pierce, Stacey, and Barkatsas (2007), had the same results that improved learning took place in a classroom mathematics course by establishing a positive attitude. In a study involving 750 students using the The Colorado Learning Attitudes about Science Survey, and conducted K. K. Perkins et al. (2004), found that learning goals were achieved quicker and more effectively with having a positive attitude towards the lesson compared to those who did not display a positive attitude. In the above study Perkins examined conceptual learning, beliefs, attitudes and the achievement level of the students in a physics class. A significant positive correlation between attitudes and information levels was found by Prokop, Leskova, Kubiatko, and Diran (2007) found a connection between a student's attitude and the students' information levels. Based on statistical data, owning a positive attitude increases the probability that a student will succeed in all lessons. Using 30 college instructors and 168 students, Liaw, Huang, and Chen (2007) explored and studied attitudes towards e-learning. To investigate students' views and opinions about e-learning, two different questionnaires were given to the participants of the study. This research suggested that included within positive attitudes was characteristics including enjoyment, usefulness and emotions of self-sufficiency. Similar conclusions were reached by Merisuo-Storm (2007) for success in foreign language where students' motivation and attitudes played very significant roles. They also concluded that if students believed their efforts will benefit them in their developmental stage or perhaps assist them in probable jobs, they would work harder.

Many students define learning as memorizing terms and equations, studying for a quiz, solving problems, and calculating numbers is how many see the learning process according to Tsai, Tsai, Yang, and Kuo (2008). Fear of getting low grades maybe the motivation for some in determining their willingness to learn. They also determined that students were more eager to learn new information when the information was relevant to them in real life applications and which they thought they could benefit from it in the future. The eagerness of some students to learn were studied and found that if a student thought the information would give them an advantage in gathering information, getting information, created an open line of communication and made it easier to find a job, they would be more open to the learning process (MerisuoStorm, 2007).

If the learning correlates with the goals, people are always motivated and ready to learn in order to achieve their personal or professional goals (Dweck & Leggett, 1988). Motivation not only is driven by the students ‘expectations and eagerness to learn a required subject but also it also contributes to their social and personal development. The top factors to be considered while fulfilling ones social duties is the attitude towards learning.

Teachers report, on average, that those students who have participated in the NASA Explorers School Project increased their involvement and interest in STEM activities while increasing their interest in STEM careers (Lutz, 2011). The results of Lutz’s (2011) study show that 79% of secondary school students polled reported they prefer learning with NASA resources over other resources. It also showed that 71% of these same students reported an easier way to learn science. Students enjoy using NASA resources overwhelmingly, with 83% of those exposed wanting to learn more about

STEM subjects after using the materials (Davis, Bettinger, & Davey, 2010). Home environment, motivation, and instructional time has the greatest influence on student achievement (Reynolds & Walberg, 1992). Students whose parents support or encourage science learning tend to have higher achievements in science along with more motivation to learn science concepts. The home environment plays a very important part in the student's motivation toward science at an early age but becomes less influential as the child gets older. How the parents foster a positive attitude about science has been found to be one of the most important predictors of science achievement (Carey & Shavelson, 1988). According to Bloom (1976), the effects of instruction on students depends in part on how student attributes and behaviors foundationally developed in their early years. Science scores have been found to be associated with the number of books with the home. Students who have access to 100 books or more at home were likely to achieve much more in science than those who come from homes that have few or no books (Valadez, 2010). Influence at home possibly assists in forming the attitudes of students learning science.

Inquiry-based learning is a technique used by the Greek philosophers to engage the student in creative thought. It has been found that inquiry-based learning techniques and methods motivate students to learn more than any other method because it generates more student interest and motivation for students (Tuan, Chin, & Cheng, 2005). This technique also provides students with more challenging and meaningful tasks and allows for students with various learning styles to experience science. In a 10-week study that investigated eighth graders' motivation outcomes after using inquiry-based teaching, Tuan et al. (2005) reported that all students showed an increase in their ability to solve science problems and became more self-motivated.

Research has linked student attitudes and achievement. In 2009, while studying the attitude-achievement paradox among blacks, Downey, Ainsworth, and Qian found a relationship between minority student attitudes toward learning and their general academic achievement. In previous studies, Singh, Dika, and Grandville (2002) noted that student attitudes and interests had a relationship with how they engaged in math and science and their subsequent achievement in those disciplines. The results from the 2003 Program for International Student Assessment research concluded that students who showed an interest in mathematics proved to be an indicator of high student achievement in math and science (Shin, Lee, & Kim, 2009). In 1978, the National Science Foundation funded a study which investigated influences on attitude toward and achievement in science among adolescent students. By analyzing the data collected during the study, researchers found that self-efficacy and anxiety about science are the strongest predictors of science achievement (Simpson & Oliver, 1990).

Attitudes about science and other disciplines can be influenced by observing the teachers' behaviors and mannerisms in a class setting. Students will often mirror their attitudes toward a particular subject by listening to the teachers' comments or making judgement on whether the teacher enjoys the subject they are teaching (Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009). This indicates teachers with high values about science can have a positive effect on the way students perceive a subject. On the other hand, a facilitator's negative values, as captured by their teaching, could be observed by the students and add less value to lessons being taught. Therefore, it can be suggested that a teacher's enthusiasm can be a catalyst to students' enjoyment in learning about science.

NASA and its promotion of space travel and outer space investments attracts many young and old people through diverse modern social media. The adventures of human space flight and the latest astronomical discoveries interest both the young and the old, which justifies its ability to lure young people into the STEM careers, thus increasing the need for aeronautics-specific curriculum (Dick & Launius, 2007). To develop economies, scientists and engineers are needed to stimulate economic growth through the development of new technologies and advances in science. Today's youth will be need to replenish the work force in these areas. Through their education processes, NASA attempts to lure students into these fields as a mechanism to increase the supply of technical capable citizens through its education portfolio. Introducing NASA disciplines at an early age may bring about an increase in students moving on a path toward STEM careers (Hatter-Williams, 2015).

NASA's curriculum, materials and instructional activities provide curricular support resources that uses space and aeronautic themes and content to enhance student skills and proficiency in STEM disciplines. NASA's mission activities are included to inform students about STEM career opportunities (NASA, 2007). NASA provides textbooks, guidelines, blueprints, learning expectations, labs and reading materials. Included are lesson plans, student laboratory and field experiences, and modeling activities that allow teachers to make educated decisions to incorporate those activities that fit into the curriculum and standard that apply for the course in question.

The National Science Education Standards state effective science curriculum materials shall be "developed by teams of experienced teachers, scientists, and science curriculum specialists using a systematic research and development process that involves repeated cycles of design, trial teaching with children, evaluation, and revision" (Herr, 2007, p. 213). In general, NASA's criteria for the development of educational materials to be useful in improving student learning and achievement includes

- They should be aligned to the specific instructional objectives of the state and district standards.
- They should be pedagogically sound.
- They should be engaging and relevant.
- They should be accurate in their presentation of scientific information.

Inspiration involves capturing the imagination and curiosity of students and turning it into motivation. Inspiration comes from access to exciting individual experiences both in and out of school. It encompasses the opportunity to be motivated by teachers, mentors and other community stakeholders. It also involves collaborations in discovery and invention, and by what they learn in school and out of school. Research shows how important it is for children to have exciting experiences in STEM disciplines starting early on, in elementary and middle school, to capture their interest and spark a lifelong passion (President's Council of Advisors on Science and Technology, 2010). These unique experiences peak their interest beyond the classroom so they can become independently curious about the world around them. Young students need to have positive experiences that demonstrate how working in a STEM field can help solve some of man's most serious problems. Curiosity helps them see themselves as scientists, technologists, engineers and mathematicians. If in eighth grade a student expresses interest in STEM subjects, he or she is three times more likely to ultimately pursue

STEM degrees later in life compared to students who show no interest (Tai, Qi Liu, Maltese, & Fan, 2006). Inspiration can comes in the form of many sources. When setting the goals for STEM education, teachers must take advantage of the opportunity to inspire students through the many avenues created by technological advances and promising programs in a variety of settings (President's Council of Advisors on Science and Technology, 2010). Inspiration is incorporated in NASA's education strategic framework.

Through the evolution of NASA's Educational design process, they have multiple ways for instructors to use the materials depending on when they were developed. NASA's education programs are described as a progressive series of stages. It is depicted as a pyramid through which their education programs move. The four levels are Inspire, Engage, Educate, and Employ. Each program can be tailored to individual needs because they can be divided by grade level, lesson objective and learning standard. This gives educators the ability to find materials that best fit their students' abilities.

Review of the Research Literature and Methodological Literature

To get a better understanding of the problem, different literature on the attitudes and perceptions of secondary students toward science as well as motivating and engaging young people in science was reviewed. Also reviewed, were studies that focused on the psychology of learning, parental influence on students, importance of STEM education, and future demands for occupations related to the fields of science, technology, and math.

Review of Research Regarding Changing Students' Attitudes Toward Science Using NASA-Designed Educational Materials

Many researchers have conducted statistical studies on the correlations between student attitudes and gender, ethnicity, ability, and other factors relating to science achievement, which identify and narrow down the factors that may contribute to the issue. "Emerging from a growing body of research in the past decade is the finding that, by age 14, for a majority of students, interest or not in pursuing further study of science has been largely formed" (Murphy & Beggs, 2005, p. 257). In a U. S. National Educational Longitudinal Study, data collected showed that if a student by the age of 14 had an interest in a science-related career, he was 3.4 times more likely to earn a sciencerelated degree (Tai et al., 2006). This same study also indicated that a 14-year-old student who has demonstrated high efficiency in mathematics will be 51% more likely to undertake a STEM-related degree. Through a survey conducted by the Royal Society (2006), it was suggested that students think about pursuing science careers prior to age 11. Likewise, a small Swedish longitudinal study found students career aspirations in science was formed by age 13 (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Lindahl, 2007). Lindahl (2007) concluded that engaging older children in science would become progressively harder.

At this point, addressing the concept of systems theory is only implied in existing research. If the purpose of studying science is to understand the universe and everything in it, then one can say that the study of science should include all the disciplines a student (ages 12–15 years) should experience in middle school. A common theme in much of the recent literature about cross-curricular work is that it improves pupils' motivation and engagement, as learning is placed in a context that is both interesting and relevant to the learner (Barnes, 2011; Muijs & Reynolds, 2011). Some studies suggest that positive attitudes are shown through the student's enjoyment of the subject, teacher encouragement and the alleviated frustrations students encounter (Schweinle, Meyer, & Turner, 2006). It has been postulated that an integrated STEM program could catapult the nation back into world leadership (President's Council of Advisors on Science and Technology, 2010).

Debates about curriculum development, design, and organization have taken place for many years (Ornstein & Hunkins, 2004; Schiro, 2013). Issues associated with interdisciplinary versus subject-based curriculum becomes controversial when differences in beliefs are evident about the type of knowledge that should be taught to the youth, who are the nation's future workforce and policy makers (Association for Middle Level Education, 2010).

Integrating curriculum is a complex process with many factors involved. Individual teachers must weigh the impact of curriculum reform on their practice. Those impacts are determined by the conceptions of the reforms and the contexts in which these reforms will be implemented (Gopinathan & Zongyi, 2006). International research has suggested that for an integrated program to be successful, teachers must understand the curriculum and be guided by that conviction. However, teachers hold different feelings and opinions of integration and which forms of integration are desirable (Lam, Chan, & Zhang, 2006). Such diversity in teachers' interpretations may be responsible for the different assertions of the nature of curriculum integration. Some studies do indicate that hands-on experiences with the implementation of a new curriculum during teacher development is more likely to induce attitudinal and conception changes (Fullan, 2007).

Unity is the driving force that makes curriculum integration a success. Wraga (2009) identified three areas that rationalize integrated curriculum. The first suggests that by making a connection across all disciplines of study, the learner will be exposed to a cumulative impact of all learning experiences (p. 92). The second focus is on how these experiences are interconnected and how schools should help the learner better understand those experiences. Lastly, that schools should equip their learners with the ability to address social problems. Two models are used by middle school level schools to structure curriculum in science. The first is discipline-based curriculum design, in which disciplines are segregated into their specialized properties. One example would be in which a mathematics instructor will include only mathematics concepts and theories throughout the life of each lesson. The second is the integrated approach to curriculum design. In integrated design, all disciplines are with a common theme.

Review of Methodological Issues

Action research is “a systematic, intentional inquiry by teachers” (Cochran-Smith & Lytle, 1993, para.1) designed to “bring about practical improvement[s], innovation, change or development of social practice” (Zuber-Skeritt, 1996, p. 83) and to “understand, improve and reform practice” (Cohen, Manion, & Morrison, 2007, p. 297). It is a process that is concerned with broader questions and the issues that impact learning, teaching across the spectrum. It is a process that is used to increase knowledge through the testing of ideas that are linked to theory and practice into one whole or ideasin-action. The spiraling nature of action research is illustrated in models by Elliot (1991) and Glanz (1998): selecting a focus, observing, reflecting, planning data collection, analyzing and interpreting data, evaluating, taking action, reflecting, and continuing to modify actions.

Action research process evolved from the need of educational researchers to want more qualitative research and inductive methods (Argyris, Putnam, & McLain Smith, 1985; Eisner, 2006; Glaser & Strauss, 1967; Lather, 1991; Lincoln & Guba, 1985; Schulman, 1986; Stake, 1995) within educational research, particularly arts-based research methods (Cahnmann-Taylor & Siegesmund, 2008; Eisner, 2002; Knowles & Cole, 2008). Such methods have allowed researchers to understand teaching and schooling practices through lenses that "liberate the concept of research from domination by science" (Eisner, 2006, p. 10) and allow for "research that brings to life the sights and sounds" of practice in any "extricable combination of observations, thoughts, feelings, intuitions, trials, errors, and discoveries" (Stout, 2004, p. 196).

Mixed research is a method in which the researcher uses quantitative methods in one phase and qualitative methods in another. This method of research can be compared to conducting two ministudies. An experiment is performed to collect quantitative data followed by an interview or other qualitative methods to see if the two agree with the results.

For this study, both the action research method and the mixed method of research was used. The action research method provided the paradigm where a conclusion could be made of the effects of using a particular intervention. The mixed method was chosen to offset the weaknesses of both the qualitative and quantitative data. Quantitative data is weak when it comes to understanding the context and the qualitative data displays weakness due to the potential for biased interpretations made by the researcher. By using the mixed research method, each approach can make up for the weaknesses of the other.

Synthesis of Research Findings

Research has dictated that teaching practices do influence students' science achievement. The long tradition of note taking is considered poor practice compared to daily life–related group experiments (Ceylan & Akerson, 2013). There is a strong relationship between student-centered teaching practices and student attitudes toward science as a predictor of science achievement (Kahle, Meece, & Scantlebury, 2000; Papanastasiou, Zembylas, & Vrasidas, 2004). As indicated through research, hands-on, inquiry-based science instruction has been linked to student achievement (Hussain & Akhtar, 2013). Many studies have documented that hands-on inquiry-based investigations have the potential to increase higher order learning skills (e.g., Dori & Sasson, 2008; Dori, Sasson, Kaberman, & Herscovitz, 2004; Kaberman & Dori, 2009; Kipnis & Hofstein, 2008). It has also been noted that inquiry-based and hands-on learning activities help students develop a higher level of motivation and positive attitudes toward science (Abd-El-Khalick et al., 2004; Hofstein & Mamlok-Naaman, 2007). Another advantage is those students who are exposed to hands-on science instruction receive significantly higher scores in science than those who are exposed to it intermittently (e.g., Jaakkola & Nurmi, 2008; Klahr, Triona, & Williams, 2007).

Critique of Previous Research

As teachers are an intricate part of delivering relevant and challenging curriculum, they too have an important part in pedagogical delivery. A review of existing literature shows a wide range of opinions and thoughts regarding the degree of knowledge a teacher should know about a subject to be effective. Unfortunately, there seems to be a lack of a concrete study that guides this issue to a conclusion. Studies do claim that most teacher knowledge studies are based on test scores, subject area exams, and self-teacher reports (Wilson, Floden, & Ferini-Mundy, 2002). These instruments do not directly check teachers' understanding, facts, concepts, and skills of a particular science concept teachers would need to convey to their students nor do they gauge teachers' understanding of the theories and principles behind teaching science. As teachers are being brought in from other areas and fields, it becomes apparent that a strong foundation in pedagogy, educational methodology, and an expertise in their specialization area are needed to improve the quality of science education in secondary schools (Grier & Johnston, 2009). Teachers influence all aspects of learning environments and can create a positive attitude toward science (Haladyna, Olsen, & Shaughnessy, 1982). Teachers play an important role as they plan, introduce, and execute new curriculum, which cannot be overlooked in science education. NASA materials can be introduced with ease but without a skilled teacher, it may not be fruitful.

Chapter 2 Summary

Research shows a link between the students' attitude toward science and science learning achievement. An improved attitude will lead to an increase in participation and perhaps increased achievement. A positive attitude means the student will pay closer attention to the presented material, purse a science interest outside of class, and become more active in homework and extracurricular activities. More time in science will calculate to higher student achievement.

The theoretical framework that encompasses this study revolves around the constructivism theories of John Dewey and Jean Piaget. Both of whom believe that learning is like building a home. As everyone comes into academia with some experiences and opinions, during the educational and learning process, more experiences are added and thus learning becomes perpetual. Out of constructivism comes other learning theories such as discovery learning and project-based learning, in which learners' takes control of their own learning processes. Given a real-life situation or problem by the facilitator, the learner is encouraged to produce a product or a creative solution to the given situation. STEM and many other integratory curriculum have shown to improve student attitudes toward science, although on small scales.

Not much literature has been published on the direct relationship between integration and cross-curriculum on the attitudes of students learning science. Many studies do infer the relationship based on circumstantial evidence. The studies noted here stated that after a child leaves elementary school, a place in which science is delivered in a fun way with not much attention paid to detail, students will lose interest in science by the time they leave middle school. Unless their mind is already set on pursuing a career in the science field at an early age, the chances of getting students to be enthusiastic or to build a positive about science will be a challenge. The effects on student attitudes toward science by the teacher may be valid but without further studies, it is only speculated.

CHAPTER 3. METHODOLOGY

Introduction

Chapter 3 introduces the reader to many facets of the research design. This chapter describes the demographics used, target population, sampling methods, and size. It describes the setting and how the participants were recruited. Details about the instruments used, tested, and validated are addressed in this chapter.

Purpose of Study

Because of the new trend introducing STEM education and the evidence that points to the stagnation in student achievement scores throughout the United States and the world, the purpose of this study was to introduce the many STEM concepts being taught in middle school using materials developed and designed by NASA in order to improve student attitudes toward science. Because NASA uses a wide range of strategies within its pedagogy, this study focused on the thematic context of the material and not the methodology.

Research Questions and Hypothesis

The primary research question that drove this study was, To what extent does the use of NASA-designed educational materials improve secondary students' attitudes towards science?

The following additional research questions helped guide the study:

1. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the areas of social benefits, positives, and negatives on scientific progress and scientific research?
2. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the way scientists are perceived?
3. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students as to the way they see the scientific method of inquiry as a valid way of thinking and that approaching a problem or situation?
4. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward scientific curiosity and openness to scientific interpretation?
5. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the enjoyment of science?
6. To what extent does the use of NASA-designed educational materials improve middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom?
7. To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward pursuing a career in science?
8. How will using NASA-designed educational materials improve student attitudes toward the learning of science?

The hypothesis formation was based on the totality of the experience of this researcher. The use of NASA educational materials will improve the attitudes of middle school students towards science.

Research Design

The design for this study was selected to align with the action research methodology and a mixed method approach. It was the intention of this study to determine if a specific intervention (NASA-designed educational materials) would significantly improve the attitudes of secondary students towards science. Both quantitative and qualitative data collection methods were used to evaluate the intervention.

Action research can be defined as "an approach in which the action researcher and a client collaborate in the diagnosis of the problem and in the development of a solution based on the diagnosis" (Bryman, Bell, Mills, & Yue, 2011, p. 414). The field of education often uses action research, an interactive method of collecting information that is used to explore topics of teaching, curriculum development, and student behavior in the classroom. The goal of academic research is usually to conduct research that will generalize to larger populations. In contrast, action researchers are more interested in gaining knowledge that can be directly applied to their own teaching context. Action research is research done by teachers for themselves (Mills, 2011). This methodology was chosen in an attempt to determine if the attitudes of students in science could be improved through a systematic process of action, evaluation, and critical analysis of collected data.

Mixed methods research has been practiced for decades. Sometimes called multimethod, integrated, hybrid, combined, and mixed methodology research, it is used to breadth or expand the scope of research to offset the weakness of either method alone (Greene, Caracelli, & Graham, 1989). There are many classificatory metrics available to researchers for description. Although there are no discrete mixed methods design options, it should be left up to researchers to plan to develop a design that addresses their needs based on the context, constraints, and boundaries of the research (Johnson & Onwuegbuzie, 2004). In this study, a concurrent design process was used. A pretest was given at the beginning of the intervention. A posttest and interview was given at the end of the intervention and a qualitative journal writing exercise was given at specific intervals throughout the intervention. This process allowed for expansion of the issues and more in-depth analysis of the research questions.

Encompassed in the mixed method design is the first of two data gathering methods. The first is the quantitative research method. Data gathered through quantitative methods is sometimes more objective, can be replicated, and can be analyzed using statistical methods. Quantitative purists argue that social sciences should be objective (Nagel, 1986). They contend that pursuing this type of data eliminates all bias and detaches the researcher emotionally and uninvolved. It is shown to empirically justify the stated hypothesis. The second is the qualitative approach method. Whereas the quantitative side of this study deals with objective numbers, the purpose of the qualitative piece of this study is to understand the more abstract psychological components of the study: experiences and attitudes.

Because the research methodology required the measure of change between participant's attitude levels before the intervention, then after the intervention, a preintervention and postintervention survey was used as a tool to evaluate the differences. The participants of this study originated from different parts of the United States, it was inferred that each were exposed to different teaching methodology and pedagogy unique to their schools. It was also inferred that each participant came to the summer program bringing different experiences, knowledge, and attitudes toward learning science. They each held different interests in the fields of science and attended the summer camp for different reasons. Each held a different level of science academic achievement and were accustomed to their own learning style. To find commonality in the data and augment this study, qualitative measurements were collected through interviews and journal entries, then coded to determine themes. The quantitative approach within this study provided the empirical evidence to be considered. Its purpose was to reveal the multiple constructs such as attitudes and experiences of each subject.

Quantitative data were in the form of the TOSRA, a 70-question, seven-category test to determine the levels of attitudes among the participants. Each subject was exposed to different learning theories from their prospective school. The qualitative method yielded the causes of likes and dislikes, one of the pillars of this study. The quantitative data were used as a tool that allowed for data collection without interrupting the operations of the research site program. Their components assisted in eliminating biases and kept the researcher detached from the study.

The instrument used to determine the science-related attitudes of the participants was TOSRA. Its purpose was to quantifiably assess science-related attitudes along seven dimensions: Social Implications of Science, Normality of Scientists, Attitude Toward Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. The TOSRA is comprised of seven subscales with 10 items each includes 70 items, each measured on a 5-point Likert scale.

After all 70 responses were processed and organized into the seven individual categories of the TOSRA, each of the seven totals was analyzed using a statistical *t* test to determine whether the null hypothesis was accepted or rejected. Using the *t* table, a comparison of the *t* statistic and the degrees of freedom determined the significance level

(p value). If $p \geq .05$ than it is likely to be a result of chance and the difference is not significant. In this case, the null is correct and there is no relationship between using NASA-related educational materials and the attitudes of students toward science learning. If $p \leq .05$, it was not likely the result of chance and the difference is significant. The null would be incorrect, therefore rejected and there would be a relationship between the use of NASA materials and the attitudes of students learning science.

Target Population, Sampling Method, and Related Procedures

Students from ages 10 to 14 were targeted for this study. Many researchers have conducted statistical studies on the correlations between student attitudes and gender, ethnicity, ability, and other factors relating to science achievement, which identify and narrow down the factors that may contribute to the issue. "Emerging from a growing body of research in the past decade is the finding that, by age 14, for a majority of students, interest or not in pursuing further study of science has been largely formed" (Murphy & Beggs, 2005, p. 257). As indicated from a review of related literature, from the age of 10 to the age of 14, there is a drastic decline in a child's interest in science. The focus and the target population for the current study were of middle school age.

The location of the study was a residential summer camp facility in which students from all over the world are invited to enhance their knowledge of aerospace using NASA-designed educational materials and subjects as curriculum. The facility is located near a major NASA flight facility and is supported NASA and local aeronautical contractors. Because of the lack of residential sleeping arrangements, only 30 students per week can participate during a one-week session. Because this camp attracts the needed demographics for this study, it was chosen as the research site for this project. All

30 of the students who attended the camp during the time period of the study met all the prerequisites and therefore participated in the study.

The sampling method was chosen based on constraints placed on the researcher by the research site aimed to maintain operational stability. All students that apply are accepted into a weeklong program provided if there is space availability and they are of middle school age. For this reason, probability sampling was administered, meaning that each individual in the population had a known probability of being selected. One week was set aside by the sponsoring organization for the purpose of this study. All participants were chosen using convenience sampling as they were enrolled in the camp on that particular week. With permission from their parents, all students at the camp volunteered to participate in the study.

Target Population

Because the research site drew participants from all over the nation, the national target population that is of interest to this study are students' ages, from 11 to 14, and enrollment in Grades 6 through 8. In 2014, according to the National Center for Education Statistics, 49.8 million students were enrolled in public education K–12. Fortysix percent were calculated as European American, 15% African American, 29%

Hispanic, 6% Asian, 1% American Indian, and the remaining were classified as Other (Institute of Education Sciences, n.d.). Out of the 49.8 million students enrolled throughout the U.S. K–12 system, 11.7 million are attending a traditional secondary school Grades 6 through 8 and range in age from 11 to 14 (U.S. Census Bureau, n.d.). This study was conducted on a small sample of 30 participants.

Sampling Method

The participants for the study was chosen using the simple sampling approach. Parents or caregivers of the study participants reached out to the research site and enrolled their student into the sites summer program. Students were added to the fall program roster based on physical space availability such as room and board accommodations. Availability was also dependent on the age and gender of each applicant. No other criteria were used. All participants who attended the fall program were eligible to participate in the study. All participants that attended the fall program volunteered to participate in the study. For the purpose of collecting qualitative data, eight participants were randomly selected using a random number generator. The eight that were selected participated in a preinterview and postinterview.

Sample Size

Thirty students participated in this study. It was impossible to study an entire population so a subset of participants was drawn from a larger set. Five private secondary schools from academic institutions over the United sent students to participate in a fall session of the program. These student participants, from the second week of the fall session camp, were invited to participate based on the enrollment of that particular session. As the students were enrolled, they were invited to participate in the study. Of the 30 students that enrolled in the program, all chose to participate in the study and parental permission was given. No enrolled participant was exempted, discriminated or disqualified from participating in the study.

The age ranges were set by the parameters of the study as most secondary school students fall into a category somewhere between ages 11 and 14. The research sites protocols request that participants are equally divided for reasons of safety.

Grade levels of participants were random as the two groups were divided according to age levels rather than grade levels per operating procedures of the research site. It was inferred that participants that were either 12 or 13 were in seventh grade.

Gender distribution was predetermined by the research site's accommodations. Out of three available on-site dormitories, one was designated the female student sleeping quarters and two were designated male student quarters as more male students attend the camp at a ratio of 2:1.

Because of the research sites organizational structure, the selection of participants by race was strictly coincidental as race was not disclosed during the application process. Chapter 4 provides specific sample data on age, grade, gender, and race.

Setting

The area in which the study was conducted is located in a remote area of the United States. The area is mostly farmland on which agriculture and livestock is the main economic support. Shell fishing and tourism industries also can be found. Approximately 74 people per square mile live in the 449.5 square mile area (U.S. Census Bureau, n.d.). The area surrounding the research site is sparsely populated.

The organization that sponsored the research is a nonprofit organization that has been in existence since 2008. It was founded by a small group of engineers and business people who recognized the need to promote STEM education. Their aim is to attract local students to STEM careers in hopes that they will pursue a STEM career and stay in the area to work in the aerospace and engineering fields.

Throughout the year, the organization solicits students ages 11–14 to come to their summer or fall camp to build and fly rockets, build and program robots, and fly quadcopters. Fall sessions are also available for local and out-of-state teachers to bring their students to use NASA materials and resources to get a better understanding of aerospace disciplines. Students tour a NASA facility that includes areas in which rockets are built, launched, and controlled. They listen to pilots who are key to specific scientific missions and take tours of the aircraft hangars that support these missions. Students also spend time at visitor center to learn about its unique history.

Students spend the nights in dormitory style living, sharing a room with five other campers their own age. Besides the exposure to rocket, robots, and drones, and related filed trips, the participants are encouraged to have fun through activities such as miniature golf, beach swimming, movies, and an ice cream social. After the week of education, fun, and fellowship, the students participate in a graduation ceremony and are given awards for their accomplishments.

Recruitment

The terms of the study was under constraints as the research site organization placed guidelines on the recruitment process within the study. Approximately three weeks before arrival at camp, along with basic camp information, an e-mail was sent out by the organization asking them to consider participating in the study. The researcher's contact information was given to the parents who were asked to contact the researcher should they have any questions. Approximately two weeks prior to their arrival at the camp, a packet containing general camp information and all study consent forms were sent via mail for parental consideration. Parents were instructed not to sign the consent forms but to bring the papers with them when they arrived at the research site.

Once the parent and child arrived on site, they were given the opportunity to ask questions face-to-face and then asked to talk with their child in private to determine if they wanted to participate. Parents were instructed to have all consent forms signed in private and returned to a third party for later review and separation to avoid any chance of alleged intimidation charges.

No incentives or extra rewards were offered to anyone regarding participating in the study or any acts thereof.

Instrumentation

Test Of Science Related Attitudes

The Test Of Science Related Attitudes (TOSRA; Fraser, 1981) is most useful for examining the performance of groups or classes of students (e.g., in curriculum evaluation), as well as providing information about attitudes at a particular time. TOSRA could also be used as a pretest and a posttest (perhaps over the time of a school term or year) to obtain information about changes in attitudes (Fraser, 1981).

To collect qualitative data, the TOSRA instrument can be used as a pretest posttest data collection tool. It is broken down into seven distinct scales that are tabulated quantitatively. They include Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. TOSRA is used by researchers, teachers, curriculum evaluators and other evaluators to monitor student progress toward achieving attitudinal aims. The TOSRA is most useful for examining the performance of groups or classes of students (e.g., in curriculum evaluation). Furthermore, as well as providing information about attitudes at a particular time, TOSRA could also be used as a pretest and a posttest (perhaps over the time of a school term or year) to obtain information about changes in attitudes (Fraser, 1981).

Fraser (1981) based his design of the TOSRA on the Klopfer's (1971) scales called the "manifestation of favorable attitudes towards science and scientists" (Welch, 2007, p. 88).

The premises of these scales are

> It is reasonable to see whether a student will speak, write, and act in ways which show that he places a positive value on the role of science in furthering man's understanding and that he give due accomplishment to scientists for their past and potential future contributions in their quest. (Klopfer, 1971, p. 519)

Fraser (1981) divided Klopfer's classifications into his own distinct divisions. The first being the Social Implications of Science scales. This measures the manifestation of favorable attitudes toward science that includes the attitudes toward social benefits, positives, and negatives on scientific progress and research (Welch, 2007). The second division is the Normality of Scientists, which determines how one perceive scientists as individuals and their lifestyles (Welch, 2007). The Attitude of Scientific Inquiry originated from Klopfer's (1971) belief that if a student believed that the scientific method of inquiry was a valid way of thinking, then his way of approaching a problem or situation was consistent with those of a scientist and therefore acting like one (Welch, 2007). The fourth division, which maintains as Klopfer's, is that of Adoption of Scientific Attitudes Towards Science. This measures the open-mindedness of students and their attitudes toward reversing their opinions on scientific investigations and inquiry and how likely they will change their way of seeing their environment after confronted with scientific evidence.

According to Klopfer (1971), "the sight, sound and smell of phenomena; the over covering of a new relationship, generalization, or explanation the spark of discussion of conflicting ideas—these are all potential sources of involvement and enjoyment" (p. 578). Fraser (1981) added these to his scale as means to measure the Enjoyment of Science Lessons. Fraser added to his scales the Leisure Interest in Science, which measures one's interest in science and science-related activities. Specifically, it reflects students' hobbies, interests, and extracurricular activities related to science outside the classroom. These were modified by Fraser from Klopfer's model as Klopfer subcategorized his scale as those students who voluntarily carry out interests by themselves and the attention they pay to societal events and the interactions with science (Klopfer, 1971, p. 578).

Both Fraser (1981) and Klopfer (1971) agreed on the classification of using the manifestation Career in Science as a measure of attitudes. Klopfer believed that when a student has such an interest in science that he pursues it as a career, he has demonstrated that he is creditable and presents himself worthy of learning science and, therefore, Fraser added it to his survey as the Career Interest in Science scale.

Fraser's (1981) TOSRA includes 70 items, each measured on a 5-point Likert scale; these items comprise seven subscales with 10 items each. The responses scale ranges from strongly agree (one) to strongly disagree (five). Out of the 10 survey questions, five are designed as positive response and five are negative with their position on science and science-related issues.

The TOSRA was given twice, once as a pretest and once as a posttest. After all 30 participants took the TOSRA pretest, a mean score was calculated for each question. Each question was then categorized according to the TOSRA scale allocation and scoring sheet provided by the TOSRA scoring sheet (Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science).

The mean of each of the questions within the specific category was calculated then the standard deviation was identified. The mean of standard error was determined by using the standard deviation using the Microsoft 2112 Excel software. By dividing the mean difference from the standard error, the *t* statistic was determined. Comparing the *t* statistic to the *t* table from San Jose State University (Gerstman, 2007), the significance level for each category was determined. Significance levels most commonly used in educational research are the .05 and .01 levels. The figure .05 implies that 95 out of 100 times, the researcher will get these results from the population surveyed.

Interview

The interview questions were designed to parallel the questions referred to in the TOSRA. A review of the interview questions and journal prompts was conducted through a panel of three experts in teaching pedagogy, assessment design, and educational leadership. Each holds a master's degree in education with tenure in the education profession. The review panel members screened the survey to determine whether the participants could read and understand the survey and questions and whether all the instruments being used reflected science-related attitudes of middle school students. Each of the five panel members were unaware and unknown to the others and evaluated the instruments at different times to ensure bias and coercion were not factors. Each panel member validated all the instruments as age-appropriate with reasonable readability for average middle school students.

The face-to-face interview questions included

- Think about the world around you. How important is the part that science plays in the advancement of technology and the way it helps people live today?
- Describe to me a typical scientist. What is your opinion about the way he/she lives, acts, behaves in a laboratory? What about their actions out of work?
- Scientific inquiry means that you learn and understand science by using the same procedures or steps true scientists use. In your opinion, is it a good or bad way of learning science? Explain in your own words.
- Your teacher wants you to find the answer to the following question: can a mouse find a piece of cheese at the end of a maze? If you were allowed to find the answer using anything or anyone as a resource, how would you go about finding the answer?
- There are times at school or at home when you are given information from someone but it doesn't make sense to you. How do you handle such situations?
- If I asked you to rate how much you like general science on a scale from 1 to 5, 1 being a big dislike and 5 a huge liking, what would that number be? Why did you choose that number?
- Think about your science class this past school year. What was your favorite area of science? Has that changed since you arrived here? Why do you think you've changed your mind? What made you change your choice, if you did?
- Curiosity is a strong desire to know or learn something. What makes you curious when it comes to nature and everything around you? Were there things at this camp that made you more curious? Do you think you are more or less curious about things now than before you got here?
- Your parents want your input on the next summer vacation. They just announced to you that you will be going to Florida, home of Disney World, Sea World, Kennedy Space Center, white sandy beaches, and many historical places. How would you like to spend your summer vacation while

in Florida? Where would you go? What would you do? What would you like to see? Put them in numerical order from the most important to you to the least.

- What occupation do you want to be involved in when you grow up and become an adult?

Journal

The journal questions were designed to parallel the questions referred to in the TOSRA and to determine to what degree did each participant participate in and enjoy the activities. A review of the journal questions and journal prompts was conducted through a panel of three experts in teaching pedagogy, assessment design, and educational leadership. Each holds a master's degree in education with tenure in the education profession. The review panel members screened the journal prompts to determine whether the participants could read and understand the questions. Each of the three panel members were unaware and unknown to the others and evaluated the instruments at different times to ensure bias and coercion were not factors. Each panel member validated all the instruments as age-appropriate with reasonable readability for average middle school students.

During the weeklong study, all participants were instructed to keep a journal to record their thoughts, behaviors and feelings. At the end of each day, unanimously the students answered questions about their experience with the intervention. After they entered their thoughts in the journal, the organizations director collected each of the entries and placed them in an envelope and gave them to the researcher. At no time or condition could the participant be identified as the student who entered a specific report.

The journal prompts were

- Describe how you interacted with the day's activities.

- How did you actively participate in the activity?
- Explain how todays activities made you think about studying science in school.
- What activity would you identify as the most fun?
- What activity do you feel you learned the most?

Once all the journal pages were collected, analyzing the data was done through a coding process. First was to identify distinct concepts and categories in the data through the open coding process. Concepts were identified then color highlighted to simplify the categorizing of the concepts. Concepts were then analyzed accordingly.

Data Collection

Prior to collecting any data for the study, approvals from the research site and the Capella University Institutional Review Board needed to be secured. The purpose of the Institutional Review Board is to ensure that it meets the institutional standards or federal regulations regarding the ethical conduct of research. Starting at the design phase of the approval process, a plan was developed that accessed the risk and benefits of conducting the study, developed the study procedures and developed a participation protection plan.

Prior to the implementation of the intervention, permission was secured from the research site for the use of the facility and the involvement of the participants in the study. Permission to use the instrument was also obtained and all permission letters and documents were sent to the Institutional Review Board along with the application for approval of the study.

Once the study was approved through the Capella University Institutional Review Board process, the research site sent out short notification about the study being conducted during the time of their child's attendance. Two weeks prior to the students' arrival, the research organization sent out a packet with copies of the consent to participate forms so the parents could review them prior to their arrival. On the day of arrival, parents and students were asked to go to the child's temporary dorm room and discuss the consent forms. Whether the parent and child agreed to participate in the study, they were to return the forms to the organization's director, who placed them in a secure envelop to protect the anonymity of the pair. Once all participants arrived at the camp, the envelope was reviewed by the researcher and the director. All parents who registered their child in the camp and all students participating in the camp signed the consent forms and agreed to participate in the study. All consent forms were given to the principal investigator of the study, who placed them in a locked and secure location.

After a quick orientation by the camp staff, the TOSRA pretest survey to collect the quantitative data was given to the counselors. After the participants filled out the survey, the site director collected all surveys, secured them in an envelope then handed it to the researcher. The envelope was then placed all the completed pretests in a locked and secured cabinet to be reviewed at a later time.

For the next five days, the intervention was injected into the daily operations of the camp and at the end of each day the students were asked to anonymously journal their feelings about their participation in the activities to gather qualitative data. After all the entries were complete, they were given to the researcher and placed in a secure and locked location to be reviewed at a later time.

On the last day of the camp, eight participants were chosen using a random number selection computer program. Once selected, one by one, the chosen students were taken to a quiet location and, in the presence of the interviewer and the organization's director, interviewed and recorded so the responses could be reviewed at a later time. All recordings were placed in a secured location and locked to be reviewed at a later time.

Lastly, prior to dismissing the students and ending the camp, the students were assembled and the posttest TOSRA was given to each child. After each child was given the opportunity to complete the posttest, the director collected all surveys and put them in an envelope then hand-delivered it to the researcher. The envelop was containing all the completed posttests were placed in a locked and secured cabinet to be reviewed at a later time.

Field Test

Because the Test Of Science Related Attitudes (TOSRA) was an existing instruments used by many organizations, this researcher accepted the field test performed by the architect.

Pilot Test

In 1987, Khalili conducted a study with students in a U.S. high school to investigate the cross-cultural validity of the TOSRA. Three hundred and thirty-six students in a Chicago suburb high school, grades 11 and 12, participated in the study. It was demonstrated that the TOSRA did have a high degree of internal consistency when used with U.S. students (Khalili, 1987).

Instrument Validity/Reliability of Pilot Study

Two fundamental components in the evaluation of a measurement instrument is validity and reliability. Validity is the extent to which an instrument measures what it is to measure whereas the reliability is the ability of the instrument to measure consistently.

The validity of the TOSRA is its ability to measure attitudes toward science and sciencerelated issues whereas the reliability of the tool is that it can measure without conflict. The reliability and validity have a close relationship as a measurement tool cannot be valid unless it is reliable (Understanding Assessment, n.d.). By using Cronbach's alpha, the most widely used objective measure, the reliability of an instrument can be measured objectively (Tavakol & Dennick, 2011).

Using Cronbach's alpha coefficient, Fraser (1981) determined the internal consistency of the scales. After administering the test to a group of secondary students, he calculated the validity and reliability of the survey. The values of alpha reliability coefficient ranged from

> 0.66 to 0.93 with a mean of 0.82 for the Year 7 sample, from 0.64 to 0.93 with a mean of 0.80 for the Year 8 sample, from 0.69 to 0.92 with a mean of 0.8 for the Year 9 sample, and from 0.67 to 0.93 with a mean of 0.84 for the Year 10 sample. (Fraser, 1981, p. 4)

The intercorrelation was low and ranged from .10 to .59 with a mean of .33 (Fraser, 1981).

Panel of Experts

A panel of experts was used to evaluate the qualitative questions. The three experts were highly qualified as they all earned a master's degree in education and are currently in educational management positions. The identities of each expert was kept away from each of the others so bias could not be introduced. Each expert is employed by a different school district and have long tenure in their organizations. All questions were sent to the experts and asked to evaluate each question for proper vocabulary, grade reading levels, context, and understanding by secondary school students. Each expert approved the questions.

Operationalization of Variables

Variables in the research include the exposure to NASA-designed educational materials, the independent variable, and student attitudes toward science, the dependent variable. Koballa (2015) argued that attitudes can be changed, but any changes are not by chance and are rather by a catalyst. Some event or causation must happen to initiate the change in thinking or behavior. When it comes to science, students are not born to like or dislike the discipline but learn to like it or dislike it. The more a student is interested in a subject the more they are motivated and will use deeper cognitive processing, thus, absorbing better conceptual understanding and higher achievement (Dethlefs, 2002). Schlechty (2002) stated that "if students become engaged in the right stuff, they are likely to learn what we want them to learn" (p. 24). The word *attitude* is used to mean students' intrinsic interest in a topic they are learning.

One of NASA's criteria for developing educational materials is that it will motivate and inspire students by creating instructional materials focused on interesting and exciting content, connecting educators and students to scientists and engineers (NASA, 2015b). NASA educational materials that are designed to motivate and inspire can cause a change in a student's attitude toward science learning.

Data Analysis Procedures

All quantitative data were analyzed through the statistical *t*-test process. A *t* table, a comparison of the *t* statistic from each category, and the degrees of freedom determined the significance level (*p* value). If $p \geq .05$ (.05 used in education) than it is likely to be a result of chance and the difference is not significant. In this case, the null is correct and there is no relationship between using NASA-related educational materials and the attitudes of students toward science learning. If $p \leq .05$, it was not likely the result of chance and the difference is significant. The null hypothesis would be incorrect and therefore rejected, and there would be a relationship between the use of NASA materials and the attitudes of students learning science.

This study also used quantitative data to determine if NASA-designed materials had an effect on the overall attitudes of middle school students toward science. All qualitative data were analyzed through an open coding system, in which transcripts and journal entries are coded to identify themes and categories.

Limitations of the Research Design

The limits of generalizability of this study is the relatively small size of the sample. Only one organization participated in the study. The size of the study was limited to the number of participants who signed up for the summer program. It cannot be certain if proportions of sixth, seventh, and eighth graders participating in this study equal to the distribution of this same population in the state or nation of this study. Generalizations about the many other educational materials NASA offers to academia cannot be made. Students participating in this summer program may have already had an interest in the materials presented.

Internal Validity

In 1987, the TOSRA was administered to classes in both the United States and Australia after the initial validation in 1977. The test was administered to determine cross-cultural validity from Australia to the United States (Khalili, 1987). The test was given to over 4,000 students in Grades 7 through 12 in Australia and in the United States.

Internal consistency was established after the administration and validation of the crossvalidation (Welch, 2007).

A review panel of experts was established to test the internal validity of the instrument. The criteria for review was to determine whether statements made in the survey reflected science-related attitudes of middle school students. A consensus of the panel indicated that the instrument is age appropriate with reasonable readability for average middle school students.

External Validity

The TOSRA instrument was created by Barry Fraser in 1979 and has been analyzed for validity. Test-retest measures were used to establish the external validity (Fraser, 1981). The test-retest measures were completed through cross-cultural validation methods. The cross-cultural validation was important to connect validity in Australia as well as in the United States (Fraser, 1981). Content validity is used to determine if designated items within an instrument connect to the intended measurement (Creswell, 2009). The content items of the TOSRA were separated into seven categories. Each category identified a specific science-related attitude.

The TOSRA was verified using discriminate validity, which is used to determine if "a given scale measures a unique attitude not measured by other scales" (Fraser, 1981, p. 4). A lack of relationship among measures is indicated by low discriminate validity. A low discriminate validity displays a positive correlation. The TOSRA scores for the total sample ranged from 0.10 to 0.59 with a mean of 0.33. Fraser (1981) contended that the "TOSRA scale intercorrelations were generally fairly low" (p. 4), meaning that sciencerelated attitudes were fairly negative.

Expected Findings

The expected findings are based on the literature review and the components of the intervention. Teachers have reported that students who were exposed to NASA materials, that included STEM activities, showed an increase interest in STEM careers (Lutz, 2011). Students enjoy using NASA resources overwhelmingly, with 83% of those exposed wanting to learn more about STEM subjects after using the materials (Davis et al., 2010). It has been found that inquiry-based learning techniques and methods motivate students to learn more than any other method because it generates more student interest and motivation for students (Tuan et al., 2005). Through their education processes, NASA attempts to lure students into these fields as a mechanism to increase the supply of technical capable citizens through their education portfolio.

NASA's curriculum materials and instructional activities provide curricular support resources that use NASA themes and content, such as space exploration missions, to enhance student proficiencies and skills in STEM disciplines. Included in the content is information about the STEM career opportunities. The curriculum used in the intervention provided real-life scenario to true application. The students were exposed to how NASA's missions impacted society, they met face-to-face with scientists and engineers, given empirical evidence that demonstrates how new technologies bring about new discoveries and were provided opportunities to have fun with science and engineering concepts with others.

Based on a logical connection between the literature review and the intervention, it is expected that there will be a statistically significant difference between the attitudes of participants toward science prior to the intervention and their attitudes after the intervention at the $p \leq .05$ level.

Ethical Issues

Because the study dealt with children it required additional scrutiny. The material used were appropriate and at grade level, which allowed for low risk. Confidentiality was low risk because there was a built-in disconnect between the students' identity and the results of all surveys.

Plans to mitigate further risk included and dealt with ethical issues as follows:

- Prior to the Capella University Institutional Review Board approval the research site was contacted and discussed with them the entire project. Preliminary approval was sought prior to any involvement with the organization. Once approval was granted, the study moved into the Capella University Institutional Review Board process.
- All consent forms were approved by the Capella University Institutional Review Board and the organization.
- Written permission from all parents of the study subjects was attained. This included general information about the study and the program, any apprehensions related to the study, and voluntariness of the study (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).
- An overview of the study was provided to all the parents and caregivers of the participants of this study. These items included the research procedure, their purposes, risks and anticipated benefits, and a statement offering the subject the opportunity to ask questions and to withdraw at any time from the research, how subjects are selected, and the person responsible for the research (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).
- Because the subjects are minors, special provision were made. Parents were given the opportunity to allow their child to participate or not. The person authorized to act on behalf of the subject was also given an opportunity to observe the research as it proceeded in order to be able to withdraw the subject from the research, if such action appeared to be not in the subject's

best interest (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

- Voluntariness was included in the research agreement with parents. This included statements that guaranteed an environment free of coercion, undue influence, unjustifiable pressures or other influencing factors (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

- The study involved academic achievements and not a social issue that historically has a high-risk value.

- The nature and scope of risks and benefits was explained to each parent/caregiver. For the purpose of this study, risks of psychological harm, physical harm, legal harm, social harm, and economic harm does not exist. No other possible harms existed.

- Selection of subjects was noted and conveyed to all parents. All students who agree to participate in this study was accepted into the summer program and was able to participate in the activities. All students who applied for the summer program was accepted and eligible to participate. No one was left out or turned away under any circumstance.

- An audit trail was maintained through the entire process. All student records were archived. Detailed journals, and lesson plans along with correspondence memos and other related artifacts have and will kept throughout and beyond the life of the study.

- This researcher maintains all documents, procedures manuals, and other vital instruments for the purposes of inquiry audits.

Researcher's Position Statement

Conflict of interest assessment. Because all information gathered in this study was anonymous, there was no issues of breach of confidentiality or undue influence. No connection exists between any persons and NASA except with use of materials. The NASA curriculum, introduction of the study how the curriculum is to be delivered was given to all parties involved. Supervision of the counselors was used to guarantee the integrity of the program presentation. No interference or redirection with any of the program activities was needed to make sure the counselors stayed on task. Every effort was made to ensure that counselors and students did not feel pressured or coerced in any way. Besides the training of the instructors, every effort was made to remove any personal bias during the lifetime of the study. No academic, financial, or other personal interests compromised the objectivity with which the research was designed, conducted, and reported.

Position statement. This only relationship to the problem was the interest in improving science attitudes of middle school student within the environment as a science teacher in a secondary school setting. Since the early 1960s, NASA has inspired many young students through the space exploration accomplishments of the United States and other countries space programs through the use of their educational materials for classroom use. To avoid any bias, all student contact, teaching pedagogy and survey administration to camp counselors and the organization director was delegated.

Ethical Issues in the Study

Working under the policies and procedures of the research site organization decreased any potential risk of harm to the participants. Informed consent was obtained from each parent for the participation of their child in the study. Every effort was made to assure that all interactions between the participants' responses to the survey, interview, and journal was guarded through securing all written and audio products in a safe and secure undisclosed location at all times. During this study, all elements of confidentiality and anonymity were absolute. Based on the study design, no one, including the researcher, had knowledge of individual survey results and journal entries. By design, the study carried an extremely low potential negative risk. Prior to the intervention, a meeting of all professional colleagues at the camp was held to discuss the purpose and the procedures of the study. All questions and concerns were considered and addressed throughout the study and out of the presence of the participants.

Chapter 3 Summary

Attitudes of students are interconnected with the way they perform academically and develop values and interest. Students will learn and retain more when the teacher maintain homeostasis between the materials and the classroom environment. NASAdesigned educational materials are designed to be engaging, meaningful and challenging that align with many learning theories.

Research questions were proposed around the TOSRA, a specifically designed instrument that determines the levels of student attitudes toward science. The designer of this test determined seven manifestations that make up the attitudes of a student toward science. They include Social Implications of Science, Normality of Scientists, Attitude Toward Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. A measure of each of these individual manifestations determine the totality of the attitudes toward science.

This chapter explained the methodology of the relationship between using NASArelated materials and whether the use significantly improves the attitudes of middle school students towards science. This action research methodology used mixed methods to get a better understanding of the problem. The quantitative data came from the use of the TOSRA survey. Qualitative data came from journal entries and face-to-face interviews. A *t*-test statistical analysis was used because it serves the purpose of telling if there is a significant difference between two sets of data (pretest and the posttest). The open coding method was used to analyze all qualitative data.

CHAPTER 4. DATA ANALYSIS AND RESULTS

Introduction

Previous research studies have indicated that the pinnacle of students' attitude toward science is at the beginning of their secondary school years, or at 10 years old (Osborne et al., 2003, p. 1060). This is the high point at which students enjoy science, believe in the scientific method of inquiry, and have strong feelings about pursuing a carrier in a science-related field. From the end of their elementary years to the end of secondary school education they lose interest in science and consider other careers options. This study was aimed to determine if the use of educational materials developed by the National Aeronautics and Space Administration (NASA) would have an effect on secondary students' attitudes toward science and therefore reverse the current trend. The methodology used in this study was of an action research format gathering data by comparing preintervention and postintervention data. Both qualitative and quantitative evidence was collected and analyzed through traditional statistical practices. Chapter 4 puts the data into perspective by presenting a description of the sample, summary of results, and a detailed analysis of all the evidence collected.

Description of the Sample

Every summer, students from all over the United States are provided the opportunity to enhance their education in science by attending a residential summer camp supported by NASA and various aerospace contractors. Because of limited residential space, the camp limits its participants to 30. These 30 participants are divided by gender and age. Female students made up 33% of the group because of the limited sleeping accommodations. Male students made up 67% of these participants, once again, because of the sleeping arrangements, and the fact that male students historically enroll in the program 2:1 over female students. At the beginning of the study, 30 participants were involved in the action research project.

The criteria to participate in both the summer program and the study was to be of middle school age, from 11 to 14 years of age, and be enrolled in a secondary school. Participants needed to have parental permission. All participants that were enrolled in the summer program were eligible to voluntarily participate in the study. Parental permission was obtained from all students attending the camp. The demographics of the participants was equally divided between male students and female students. The division of ages were broken down equally into groups of 11- and 12-year-olds and a second group of 13- to 14-year-olds. Levels of academics were diverse as 43% of these participants were attending the eighth grade whereas 33% attended seventh grade. Twenty-four percent were going into the sixth grade. Various races were represented within the study sample including 58% European American, 33% African American, 6% Hispanic, and the rest of other racial categories.

The age ranges were set by the definition of the study as most secondary school students fall into a category somewhere between ages 11 and 14. The research site set the percentages for safety reasons as they prohibit, by their operations procedures, to have older participants residing in dorms with younger students. Table 1 displays the distribution according to age ranges.

Table 1. Participant Age

Age	Percent
11-12	50%
13-14	50%

Grade-level participants were random as it was the age levels that segregated the two groups and not grade levels. It was inferred that participants that were either 12 or 13 were in seventh grade. Table 2 shows how the participants were divided among the grade levels.

Table 2. Participant Grade

Grade	Percent
6	24%
7	33%
8	43%

Gender was predetermined by the research sites accommodations. Out of three available on-site dormitories, one was designated as the female sleeping quarters and two were designated male quarters. Table 3 shows the distribution of the gender during this study.

Table 3. Participant Gender

Gender	Percent
Female	33%
Male	67%

Because of the research sites organizational structure, the selection of participants according to race was strictly coincidental as race was not disclosed during the summer program application process. Table 4 displays the racial distribution during the study.

Table 4. Participant Race

Ethnicity	Percent
European American	58%
African American	33%
Hispanic	6%
Other	3%

Summary of the Results

In order to determine a difference between preintervention attitudes and postintervention attitudes an analysis of each of the seven manifestations that make up science attitudes of students needed to be completed. The research question posed was: To what extent does using NASA-designed educational materials improve secondary student's attitudes towards science?

The following research questions helped guide the study:

1. To what extent does using NASA-designed educational materials improve the attitudes of middle school students toward the areas of social benefits, positives, and negatives on scientific progress and scientific research?

2. To what extent does using NASA-designed educational materials improve the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles?

3. To what extent does using NASA-designed educational materials improve the attitudes of middle school students as to the way they see the scientific method of inquiry as a valid way of thinking and that approaching a problem or situation?

4. To what extent does using NASA-designed educational materials improve the attitudes of middle school students toward scientific curiosity and openness to scientific interpretation?

5. To what extent does using NASA-designed educational materials improve the attitudes of middle school students toward the enjoyment of science?

6. To what extent does using NASA-designed educational materials improve the attitudes on the enjoyment of science as a hobby outside the classroom?

7. To what extent does using NASA-designed educational materials improve the attitudes of middle school students toward pursuing a career in science?

8. How will using NASA-designed educational materials improve student attitudes toward the learning of science?

To gather quantitative data, the participants of this study were asked to respond to a 70-question instrument. The Test Of Science Related Attitudes (TOSRA; Fraser, 1981) is a validated tool that assesses seven categories that manifest into students' attitude toward science. The seven subscales are Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. Prior to the intervention, participants responded to the TOSRA, which measured student attitudes toward traditional learning methodology they experienced from the school they had just attended. At the end of the intervention, participants were again asked to respond to the

TOSRA. The preintervention and postintervention data were compared. Qualitative data were retrieved through the use of interviews and daily journal writings from the participants. The qualitative data were analyzed by an open coding method that extracted themes and commonalities. Both the qualitative and quantitative data presented a portrait of the findings.

The quantitative data were collected through the TOSRA. Its purpose and design is to quantifiably assess science-related attitudes along seven dimensions: Social Implications of Science, Normality of Scientists, Attitude Toward Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. The TOSRA is comprised of seven subscales with 10 items each. Each subscale is measured on a 5-point Likert scale.

After all 70 responses were processed and organized into the seven individual categories of the TOSRA, each of the seven totals was analyzed using a statistical *t* test to determine whether the null hypothesis was accepted or rejected. The *t* test was used to compare the preintervention attitudes and the postintervention attitudes of each participant because the 30-student sample was small. Because two sets of data was being compared, preintervention and postintervention, the two-tailed test was used. An independent *t* test was used to compare the differences between the preintervention and postintervention data of the seven dimensions within the TOSRA. The independent *t* test (two-tailed) was be used to compare the means of students' scores at levels of significance of .05 or levels used in both science and education. Using the *t* table, a comparison of the *t* statistic and the degrees of freedom determined the significance level (p value), if $p \geq .05$ than it is likely to be a result of chance and the difference is not significant. In this case, the null is correct and there is no relationship between using NASA-related educational materials and the attitudes of students toward science learning. If $p \leq .05$, it was not likely the result of chance and the difference is significant. The null would be incorrect, therefore rejected and there would be a relationship between the use of NASA materials and the attitudes of students learning science.

An analysis of the quantitative data of the seven dimensions revealed that under the same conditions as this study, the use of NASA-designed educational materials would not have an effect on secondary students' attitudes toward science.

Detailed Analysis

In this detailed analysis, the supporting data that was used to answer the research questions are presented. Seven categories of the TOSRA are the manifestations that make up a student's overall attitude; therefore, each category was hypothesized and a null hypothesis was formed. Each of the seven categories was analyzed individually in order to answer the corresponding research questions which are discussed in this analysis. The answer to the following primary research question was a culmination of all seven final measures in both qualitative and quantitative measures: To what extent does using NASA-developed educational materials significantly improve the attitudes on middle school student attitudes toward science?

Quantitative Analysis

Quantitative data collected from participants in the study consisted of their responses to the questions within the seven categories of the TOSRA. These categories include Social Implications of Science, Attitude Toward Scientific Inquiry, Adoption of

Scientific Attitude, Enjoyment of Science Lesson, Leisure Interest in Science, and Careers in Science.

Social Implications of Science. The first of seven categories found in the TOSRA is the Social Implications of Science. The Social Implications of Science scale is a measure of the favorable attitudes toward science that includes the attitudes toward social benefits, positives, and negatives on scientific progress and research (Fraser, 1981). It is a belief that science plays a major role in solving social problems through research and development of new technologies. The research question guiding the collection and analysis of data for this category was Research Question 1, To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward on the social benefits, positives, and negatives on scientific progress and scientific research?

Table 5 was compiled from the 10 survey questions (1, 8, 15, 22, 29, 36, 43, 50, 57, 64) of the TOSRA under the manifestation category Social Implications of Science. It represents the quantitative results from tabulating the 10 survey questions that relates to the social implications of science from the 30 participants.

The null hypothesis for this category was Null Hypothesis 1, Using NASAdeveloped educational materials will not significantly improve the attitudes of middle school students toward social benefits, positives, and negatives on scientific progress and scientific research.

After analyzing the 10 questions relating to the social implications of science from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was 1.92, which is greater than .05, or 1.92 > .05, the significance level used in education. This interprets into the null hypothesis being accepted based on the quantitative data. Therefore, based on the data collected through the TOSRA, NASA educational materials would significantly improve the attitudes of middle school students on social implications of science.

Table 5. Survey Results on Social Implications of Science

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 1	3.33	4.21	0.88
(2) 8	3.36	4.5	1.14
(3) 15	4.21	3.81	−0.40
(4) 22	4.27	3.71	−0.56
(5) 29	3.54	3.59	0.05
(6) 36	3.87	3.40	−0.47
(7) 43	3.60	4.15	0.55
(8) 50	3.75	3.65	−0.10
(9) 57	3.87	4.56	0.69
(10) 64	3.45	3.96	0.51
Mean difference			0.23
Standard deviation of the mean			0.37
Standard error			0.12
T statistic			1.92

Normality of Scientists. The next category from the TOSRA contains a group of survey questions concerning the normality of scientists, which determines how one perceive scientists as individuals and their lifestyles (Welch, 2007). How students perceive scientist is a manifestation of the overall attitudes toward science. The research question guiding the collection and analysis of data for this category was Research Question 2, To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles?

Table 6 contains data from the normality of scientist category of the TOSRA. It represents the quantitative results from tabulating the 10 survey questions that relates to the normality of scientists from the 30 participants.

The null hypothesis for the normality of scientist is Null Hypothesis 2, Using NASA-developed educational materials will not significantly improve the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles.

After analyzing the 10 survey questions relating to the normality of scientists from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was $p = -.43$. Because the *t* statistic is less than .05, or $-43 < .05$, the null hypothesis is rejected. Therefore, based on the data collected through the TOSRA, NASA educational materials would have a significant improvement on students' attitudes toward perceiving scientists as normal individuals.

Table 6. Survey Results on Normality of Scientists

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 2	4.48	2.93	−1.55
(2) 9	4.24	3.18	−1.06
(3) 16	3.78	3.40	−0.38
(4) 23	3.51	3.46	−0.05
(5) 30	3.57	3.59	0.01
(6) 37	3.24	4.03	0.79
(7) 44	3.96	3.78	−0.18
(8) 51	3.45	3.62	0.17
(9) 58	4.03	3.43	−0.60
(10) 65	3.90	3.81	−0.09
Mean difference			−0.29
Standard deviation of the mean			2.15
Standard error			0.68
T statistic			−0.43

Attitude to Scientific Inquiry. Attitude of scientific inquiry is interpreted as a student's belief that the scientific method of inquiry is a valid way of thinking or approaching a problem or situation and is consistent with those of a scientist and, therefore, acting like one (Klopfer, 1971). The scientific method is a variety of procedures for investigating phenomena, acquiring new knowledge, or testing hypothesis. Based on collecting measurable and empirical evidence, the method of inquiry is based on specific principles of reasoning. The research question guiding the collection and analysis of data for this category was Research Question 3, To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students on the way they see the scientific method of inquiry as a valid way of thinking and that approaching a problem or situation?

Table 7 illustrates the statistical data found in the Attitude to Scientific Inquiry, one of the manifestations of the overall science attitudes of students. After analyzing the 10 questions relating to the attitudes toward scientific inquiry from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was −2.12. This equals to a $p > .05$, or $-2.12 < .05$, that the null hypothesis would be accepted. Therefore, based on the qualitative data collected through the TOSRA, NASA educational materials would have a significant improvement on middle school student's attitudes toward their perception of scientific inquiry as the null hypothesis was rejected. The null hypothesis for the attitude toward scientific inquiry was Null Hypothesis 3, Using NASA-developed educational materials would significantly improve the attitudes of middle school students on the way they see the scientific method of inquiry as a valid way of thinking and approaching a problem or situation.

Table 7. Survey Results on Attitude to Scientific Inquiry

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 3	3.90	3.54	−0.36
(2) 10	4.31	3.63	−0.68
(3) 17	4.31	3.39	−0.92
(4) 24	3.78	4.03	0.25
(5) 31	3.84	3.63	−0.21
(6) 38	3.75	2.78	−0.97
(7) 45	4.68	3.75	−0.93
(8) 52	3.68	3.84	0.16
(9) 59	3.5	3.84	0.34
(10) 66	3.59	3.51	0.08
Mean difference			−0.34
Standard deviation of the mean			0.51
Standard error			0.16
T statistic			−2.12

Adoption of Scientific Attitudes. The adoption of scientific attitudes toward science is a measures the open-mindedness of students and their attitudes toward reversing their opinions on scientific investigations and inquiry and how likely they will change their way of seeing their environment after confronted with scientific evidence. The ability to change their conclusions when new evidence presents itself is a manifestation of the overall attitudes of students toward science.

The research question guiding the collection and analysis of data for this category was Research Question 4, To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward scientific curiosity and openness to scientific interpretation? Table 8 shows the statistical distribution of the data. The null hypothesis for the attitude toward adoption of scientific attitudes was Null Hypothesis 4, Using NASA-developed educational materials will not have a significant effect on middle school students' attitudes toward reversing their opinions on scientific investigations and inquiry and how likely they will change their way of seeing their environment after confronted with scientific evidence.

After analyzing the attitudes toward scientific inquiry from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was p =.5. This equals to a $p > .05$, or $0.5 > .05$, that the null hypothesis would be accepted. Therefore, based on the qualitative data collected through the TOSRA, NASA educational materials would not significantly improve the attitudes of middle school students toward their perception of scientific inquiry.

Table 8. Survey Results on Adoption of Scientific Attitudes

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 4	4.03	3.25	−0.78
(2) 11	3.81	3.68	−0.13
(3) 18	4.03	4.37	0.34
(4) 25	4.0	4.37	0.37
(5) 32	3.90	3.71	−0.19
(6) 39	3.48	4.34	0.86
(7) 46	3.78	4.09	0.31
(8) 53	3.84	3.71	−0.13
(9) 60	3.75	3.5	−0.25
(10) 67	3.15	3.87	0.72
Mean difference			0.11
Standard deviation of the mean			0.71
Standard error			0.22
T statistic			0.50

Enjoyment of Science Lessons. The degree in which a student engages and participates in science activities is a manifestation of overall attitudes toward science by students. Enjoyment of science lessons involve all aspects of learning science and is another manifestation of overall science attitudes. It is the way students involve themselves in the way science is presented that enables them to engage in science-related discussions and share conflicting ideas (Klopfer, 1971, p. 578). It means that a student enjoys science in either a formal educational institution or an informal setting.

The research question guiding the collection and analysis of data for this category was Research Question 5, To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward the enjoyment of science lessons? Table 9 illustrates the statistical distribution of the collected data within the dimensions of the Enjoyment of Science Lessons of the TOSRA. The null hypothesis was Null Hypothesis 5, The use of NASA-developed educational materials will not have a significant improvement on middle school students' attitudes toward the enjoyment of science.

After analyzing the 10 questions relating to the enjoyment of science lessons from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic is $p = 2.45$, or $2.45 > .05$, or that the null hypothesis is accepted. Therefore, based on the qualitative data collected through the TOSRA, the use of NASA educational materials would not significantly improve middle school attitudes toward the enjoyment of science lessons.

Table 9. Survey Results on Enjoyment of Science Lessons

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 5	4.30	3.81	−0.49
(2) 12	3.66	4.40	0.73
(3) 19	3.48	3.90	0.42
(4) 26	3.48	4.09	0.60
(5) 33	3.75	4.28	0.52
(6) 40	4.0	4.43	0.43
(7) 47	3.60	3.43	−0.16
(8) 54	3.51	3.81	0.29
(9) 61	3.81	3.96	0.15
(10) 68	3.69	4.06	0.36
Mean difference			0.28
Standard deviation of the mean			0.37
Standard error			0.11
T statistic			2.45

Leisure Interest in Science. Another manifestation of overall science attitudes is Leisure Interest in Science. This dimension reflects students' hobbies, interests, and extracurricular activities related to science outside the classroom. It also measures students who voluntarily carry out interests by themselves and the attention they pay to societal events and the interactions with science (Klopfer, 1971).

The research question guiding the collection and analysis of data for this category was Research Question 6, To what extent would the use of NASA-designed educational materials improve middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom? Table 10 displays the statistical data derived from the 10 survey questions in this category of the TOSRA. The null hypothesis was Null Hypothesis 6, The use of NASA-developed educational materials will not significantly improve middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom.

Table 10. Survey Results on Leisure Interest in Science

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 6	3.51	3.81	0.29
(2) 13	3.45	3.59	0.13
(3) 20	3.15	3.71	0.56
(4) 27	2.87	3.40	0.52
(5) 34	4.0	3.96	−0.03
(6) 41	3.48	3.59	0.10
(7) 48	3.27	3.56	0.28
(8) 55	3.12	3.25	0.12
(9) 62	3.72	3.87	0.14
(10) 69	3.51	3.68	0.17
Mean difference			0.23
Standard deviation of the mean			0.18
Standard error			0.05
T statistic			3.92

After analyzing the 10 questions relating to the leisure interest of science from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was 3.92. This interprets as p >.05, or 3.92 > .05; therefore, based on the qualitative data collected through the TOSRA, the use of NASA educational materials would not significantly improve middle school attitudes the leisure interest in science.

Career in Science. Klopfer (1971) believed that when a student has such an interest in science that he pursues it as a career, he has demonstrated that he is credible and is worthy to learn science and, therefore, Fraser (1981) added it to his survey as the Career Interest in Science scale.

The research question guiding the collection and analysis of data for this category was Research Question 7, To what extent does the use of NASA-designed educational materials improve the attitudes of middle school students toward pursuing a career in science? Table 11 illustrates the data extracted from the TOSRA career in science dimension. The null hypothesis for careers in science was Null Hypothesis 7, The use of NASA-developed educational materials will not have a significant improvement on middle school students' attitudes toward pursuing a career in a science field.

After analyzing the 10 questions relating to careers in science from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic is 2.12, or 2.12 > .05. This interprets as NASA educational materials would not significantly improve the attitudes toward careers in science and the null hypothesis would be accepted.

Based on data extracted from the TOSRA survey, 6 out of the 7 categories used to measure the attitudes of students in science showed that using NASA-developed educational materials would not significantly improve the attitudes of students learning science.

Table 11. Survey Results on Career in Science

Scale Question No.	Pretest mean	Posttest mean	Difference
(1) 7	3.54	3.90	0.36
(2) 14	3.63	4.31	0.68
(3) 21	3.39	4.31	0.92
(4) 28	4.03	3.78	−0.25
(5) 35	3.63	3.84	0.21
(6) 42	2.78	3.75	0.97
(7) 49	3.75	4.68	0.93
(8) 56	3.84	3.68	−0.16
(9) 63	3.84	3.5	−0.34
(10) 70	3.51	3.59	0.08
Mean difference			0.34
Standard deviation of the mean			0.51
Standard error			0.16
T statistic			2.12

Qualitative Data From Interviews

The first method used to collect the qualitative data was a face-to-face interview with a small sample of participants. Prior to the interview, each student was given a number based on their position on the enrollment records. The executive director of the summer program used a random number selector application on a cell phone to choose eight numbers. The participants selected were all given permission by their parents to participate in the interview process.

The interview took place in cafeteria setting with the executive director present per the organizations child safety plan. All questions and responses were audio taped for accuracy during the transcript assembly process. All the participants appeared before the interviewer to be timid and shy through the interview process. Each interview lasted approximately 10 minutes to give each interviewee a chance to collect thoughts before answering. No follow-up questions were asked for fear of maneuvering statements toward a more favorable or misspoken response. None of the interviewees were compensated in any way for the interview.

The analysis method used was a thematic coding process. This is a process in which the researcher can alter and modify the analysis as interpreted by the data as new ideas emerge. Taken directly from the audio taped interviews, the dialogues were transcribed the statements made throughout the eight interviews. Because the data from the interviews were divided into seven different themes, an analysis of each theme separately was used and compared to analyzing each interview looking for themes. The next step involved coding all the data by hand, color coding keywords and concepts that captured the qualitative value of the phenomenon. Coding for consistency, validation, and outliers was evaluated so they can be eliminated from the data. From the coding themes, subthemes, and specific patterns by vocabulary and conversation topics could be identified. Lastly, descriptions and quotes from each theme were finalized to help communicate its meaning to the reader.

The interview questions were developed for this study and were field tested by panel of experts to determine if each was appropriate to the study and to secondary school–aged students. The questions had a direct relationship to each of the seven manifestations of overall student science attitudes.

Research Question 1: Social Implications of Science. The interview question was asked, After participating in this camp, how important do you think science is toward improving the lives of people on Earth? Can you give an example? Coding revealed that the participants understood the importance of science in society. One of the common themes occurring in the responses was that science helps solve earth's problems or help prevent problems on Earth. Following are participant interview responses related to Research Question 1:

- Participant A: "Science is very important to us. Electronics always seem to help people in some way and without science, electronics would not exist. Without science, we wouldn't know about the earth and how to take care of it. Probably everything we use here on earth is because we have science."
- Participant B: "I know how science is important because without it, we would not understand the weather or be able to identify things like plants and the foods we eat. We can't live without science because it is helping us find cures for cancer and illnesses. From the smallest to the greatest things, science is there."
- Participant C: "I think science is very important towards life because it helps us understand things like the greenhouse effect, animals on farms, and things that are hurting our environment. Science is important because it keeps people healthy or if they are not, science can help us to understand and learn more about what makes us sick."
- Participant D: "Without science, we could not tell if something is affecting us like global warming. I would not know if my dog was sick without science or if I can go outside without the fear of thunder and lightning. Without science, we couldn't do things like find a cure for cancer or even see what foods are healthy for us."

- Participant E: “I think science is very important because it can improve life by finding new ways of using less things that will pollute the earth for example battery powered cars. Without science, you can’t tell when it is going to rain or which planet is which.”

- Participant F: “I think it’s very important because if a weird gas is released from a factory or something, they can tell people if it is dangerous or not. Science is helping us find and cure diseases or illnesses from people. We are finding ways to help people live and not die. Science is also teaching us how to make the world cleaner and a better place.”

- Participant G: “It is very important. An example is, what if we had to build a space shuttle to withstand 1000°. That means that science would be used to build it. It also helps us understand how things are created like how fossils are formed. Science is very important because we need science to help us solve the problems we have on earth. Science is going to help us protect the animals and people in Alaska.”

- Participant H: “Science must be important because we have to study it in school. My teacher makes us do these assignments where we need to look up some of Earth’s problems and see what people are doing about them.”

Research Question 2: Normality of Scientists. The question for this category was to describe a scientist. Analysis of this category revealed that the participants had many misconceptions about scientists and what they do. According to the coding results, the participants carry many misconceptions about how scientists live and work.

Following are participant interview responses related to Research Question 2:

- Participant A: “I think scientist are really smart. They work in big laboratories with fancy electronics around them. They work at a large company making things like medicines and other medical stuff.”

- Participant B: “They are intelligent and know everything about everything. They can solve the problems of the world if they had the right equipment. They know how to do chemistry, and solve math problems. They spend most of their time doing math.”

- Participant C: “Most of them work at a school or college. They don’t make much money so they are allowed to live in rooms at the school. They know how to solve a lot of problems with their knowledge of math and other subjects.”

- Participant D: “I learned that there are so many different scientist, especially at NASA. They do so much to help the world’s problems like global warming and the ice sheets melting. Besides using test tubes and burners, they use airplanes and go to interesting places. I’m sure they don’t have families because they are away from home a lot trying to solve Earth’s problems.” • Participant E: “They have to know everything to be a scientist because they never know what problem they are going to solve. They usually do their work in large laboratories with a lot of measuring tools. Most of their time is doing things with test tubes and thermometers. Because they are busy all the time, they don’t have a wife or a home.”

- Participant F: “Different scientists do different things. Some solve problems like global warming and other make things like medicines and things that help people. Scientist at NASA fly in airplanes and measure the atmosphere and the amount of ice in colder parts of the world.”

- Participant G: “Scientist are people that solve the world’s problems using the newest equipment to measure what they are studying. They work for different companies that are in charge of solving specific problems here on Earth. I think they make a lot of money because there are not many of them working.”

- Participant H: “I guess in order to be a scientist, you must be required to work a long time on a problem. Scientists are cool.”

Throughout the summer program experience, students were exposed to the social implications of science that may or may not have influenced their response to the interview question. The social advantages and benefits of exploring space is highlighted in the intervention used in this study. It is also contained within the educational materials and reinforced in the guided NASA tours that the students partook. One of the field trip tour stops was the opportunity to be briefed by a NASA scientist/pilot who explained how his flights were designed to benefit mankind. It was difficult to determine based on the interview responses if the participants came to their responses prior to participating in the summer experience or the exposure they had experienced changed their position on science in society. More research is needed to answer that question.

Research Question 3: Science Inquiry. The interview question was asked, Scientific inquiry means that you learn and understand science by using the same procedures or steps true scientists use. In your opinion, is it a good or bad way of learning science? Explain in your own words. Following are participant interview responses related to Research Question 3:

- Participant A: "I think there are other ways to get answers to what we want to know. I wouldn't use the scientific method because there are [*sic*] more than one way to do an experiment."

- Participant B: "Scientific inquiry is a good way of learning science because you find out on your own what you want to know. I believe that using the scientific method either proves your hypothesis or not. We have to do things the right way because it involves our lives, which science is a part of. I would rather do the experiment myself."

- Participant C: "I do believe that it is useful because it makes you go more into depth than most people. It is also a good because it shows you how a scientist would learn something, plus, scientists are insanely smart people. Most of the time I stick to the method, but have thought about other ways of doing an experiment because some of those procedures are hard and very detailed."

- Participant D: "Scientific inquiry means to find out new things you didn't know before. Whether you use the scientific method or not, I don't think there is a better way to learn science as long as it's safe for everyone around you. As long as it's safe, I think I would find another way of doing the experiment. We should be able to learn different ways to do things, not just simple ways to do it but different ways in case the first thing did not work. I think using the method is a good choice but in other experiments I'm not so sure. The scientific method is good for something but not good with others. In this case the experts know more than me."

- Participant E: "It's a good way. You can learn a lot more by doing an experiment. I wouldn't deviate from the seven steps of the scientific method. It's a fun way to do science and learn something new. Also when you do the exact thing that scientist do you know the results plus you experienced it. You also know how you got the answer. I would try something else because the experiment is easy."

- Participant F: "It's a fairly good way of learning science because personally, I learn hands-on. It's an efficient way to make sure you have all your data.

As you use it you gather data as what it is and not necessarily what the textbook wants to tell you it is. It's cool to learn the same procedures as the real scientist and know it is correct. I would start with gathering data using reliable sources. But I would stick to the scientific method because I know it works. But given a time limit, I would probably just do it quickly, forgetting the scientific method, not writing it out and keeping it in my head." •

Participant G: "I think it's a good way because science through questions make other people feel that they can build on your question by asking another question. It's a change so that more and more questions are being answered throughout the chain. I think it is a good idea to have steps or procedures because if you try to figure out a problem and solve the that problem, you need to have steps so other people can solve the problem to or for you to go back to that problem to see if you made no mistakes or to see if you have the same answer. I think you can deviate from the scientific method of inquiry because many experiments do not need to be that in-depth. A maze and a mouse is pretty straightforward but a rocket launching would be more detailed. Collecting would come in the end no matter what you do. The scientific method is more of a guide and not necessarily the bible of science."

- Participant H: "In my opinion there is more than one way to do an experiment. You can do many things to get the same results in an experiment. Besides, sometimes, we need to make mistakes for some people to learn. If we use the same steps, then we don't get to figure it out on our own. Finding out our own ways makes us listen to each other and makes us think in different ways and experience trial and error. I would conduct an experiment. I believe that the scientific method is not the only way to conduct an experiment and that I could get results doing it a different way."

Analysis of this question uncovered that many of these participants did not understand the purpose of the scientific method of inquiry. Many of the responses inferred that the method of scientific inquiry was a way of learning science and not a way of solving problems through steps and procedures. Only a small percent of the participants made reference to answering a scientific question through the steps of the scientific method. Without researching into the pedagogy of the participants' scientific background, it is impossible to determine if middle school–aged students truly understand the scientific method.

Research Question 4: Adoption of Science Attitudes. The question posed to the participants was, There are times at school or at home when you are given information from someone but it doesn't make sense to you. How do you handle such situations? Also the question was asked, Curiosity is a strong desire to know or learn something. What makes you curious when it comes to nature and everything around you? Were there things at this camp that made you more curious? Do you think you are more or less curious about things now than before you got here? Following are participant interview responses related to Research Question 4:

- Participant A: "I just walk back to my room and think about it. I do ask a lot of questions but I also answer them myself after I asked it. I am curious about a lot of things. I walk outside and see a bird flying so I want to read about and study it. I was in Cub Scouts for 2 years and I enjoyed the way the scouting program makes us curious. The Apollo missions are my point of interest mostly and then when you did the trivia questions, I wish I had known the answers."

- Participant B: "I might go look it up in a book or search it on google. I would go out of my way to look it up. Any question that doesn't have an answer, too. I want to know. I want to find out everything before I get old. I was always curious about the breakdown of NASA. I didn't know that each center does something different. But I've always been a curious person."

- Participant C: "Either I will keep asking questions or ask someone else who understands it. I enjoy asking questions because I like to learn more than that behind everyone else. I think studying space stuff here made me more curious about science in general. The only thing I'm really curious about is why plants are considered living things. Other than that, I'm not really curious."

- Participant D: "If it strikes my interest, I will find out on my own through books and other reliable sources. I think it's in me but the more I learn, the more curious I am. I'm curious about mostly everything probably because every little thing can lead to one giant effect. Nothing really makes me more curious than nature because everything we have comes from curiosity."

- Participant E: "I ask questions from a buddy, adult, or teacher. I want to know how things work and to see how they work. I'm a curious person by nature. I think I'm more curious since I came here than before. But I'm also curious about the things outside like nature and animals. I'm more interested in cars and dogs, although I'm more curious about space [than] I was before."

- Participant F: "Talk to other people if I can or I would do my own research, figure it out myself, and build something."

- Participant G: "Depending on the class I would wait till the end of the lesson then ask the question. If I'm at home I would ask my parents. I think how something grows makes me curious about nature. I think learning space has made me more curious. Since coming to camp, I've become more curious about the Earth like the wind, water, and air. Sometimes, when I look at the cover of a book, I become more curious."

- Participant H: "I ask for an explanation from that person but in different words. If I still don't understand I would ask them directly and to explain thoroughly until I completely understand. I kind of go with the flow. I'm not that curious about things in nature. While I was here at the academy, it did make me more curious about things."

All responses remarked that they would find different ways to answer specific questions. It appears that participating in the NASA program did not affect the degree of curiosity from preintervention to postintervention.

Research Question 5: Enjoyment of Science. Another question was asked to determine if the NASA educational materials made an impact on the way the participants felt about science in general. Analysis of the qualitative data showed that although the participants were exposed to many science concepts related to aeronautics and space, they held on to their interests in other topics while at the summer program. The question was asked, Think about your science class this past school year. What was your favorite area of science? Has that changed since you arrived here? Why do you think you've changed your mind? What made you change your choice, if you did? Another question asked was, if I asked you to rate how much you like general science on a scale from 1 to 5, 1 being a big dislike and 5 a huge liking, what would that number be? Why did you choose that number? Following are participant interview responses related to Research Question 5:

- Participant A: “My favorite area of science was our energy unit. Our supervisor of schools challenged us to this . . . project-based learning. It was great to solve a problem. Even the camp couldn’t beat that.”

- Participant B: “In seventh grade, we learned biology and I loved it. I think biology is great and my favorite part is learning about cells and diseases, because of my interest. I like both biology and space science equally.”

- Participant C: “I like chemical compounds. I’ve been more interested in chemical compounds but learning about space made me like science even more. I don’t think I like science more because I learned about space. Nothing really changed.”

- Participant D: “Because when I see stuff, I always want to find out how it works and study it. Learning about science made me more curious and more eager to learn. I want to learn more about space since I came here.”

- Participant E: “I did enjoy robotics because we had a robotics class in my school and it has not changed since I [have] been here.”

- Participant F: “My favorite would have to be chemistry. After learning about space, my favorite area of science is still chemistry. I enjoy seeing how particle A interacts with particle B.”

- Participant G: “My favorite subject would be meteorology because it’s complex and yet simple depending how far you want to go. It was fun collecting data over a year and comparing data. Learning about space did not change the way I feel about meteorology.”

- Participant H: “Probably chemistry. I was good at it. Because we learned about space in school, I don’t think it changed my mind being here.”

Research Question 6: Leisure Interest in Science. The question was, Your parents want your input on the next summer vacation. They just announced to you that you will be going to Florida, home of Disney World, Sea World, Kennedy Space Center, white sandy beaches, and many historical places. How would you like to spend your summer vacation while in Florida? Where would you go? What would you do? What would you like to see? Put them in numerical order from the most important to you to the least.

Analysis of this question showed no consistencies and only once during the interviews reveal no relationship between an enjoyment of science during leisurely time. Although a science-themed place may have been first choice for some, how the participants like spending their leisure time was just as diverse as the participants themselves. Following are participant interview responses related to Research Question 6:

- Participant A: “I would choose Kennedy Space Center first because I’ve been to Florida three times and every time I go, I see something new. I was going to see the Saturn V Center but it was closing when we got there. My next choice are the historical sites then Sea World and last Disney.”
- Participant B: “I would go to the sand beaches because I don’t care for Sea World much. I’d go to Disney next.”
- Participant C: “I would want to go back to the Kennedy Space Center.”
- Participant D: “Robotics camp first. I think I would go to Sea World because I’m more curious about animals.”
- Participant E: “My first choice would be St. Augustine because I like learning from different cultures and studying the past. Kennedy Space Center would be second because I like rocketry. Disney World would be next only because of the recent cruelty to animals’ reports at Sea World. Sand beaches would be nice as my last choice.”
- Participant F: “My first place would be to go to Kennedy Space because I’ve always had an interest in it. Next would be Disney because it is fun. Historical places would be my next choice then Sea World. I’m not a beach person.”
- Participant G: “I would choose Disney first because a vacation is also used to create memories and reduce stress in our lives.”
- Participant H: “I would actually go to the beach than Kennedy Space Center. Then historical places then Disney. I like Universal better than Disney.”

Research Question 7: Career Interest in Science. The question posed for this category was, What occupation do you want to be involved in when you grow up and become an adult?

Analysis of this interview question proved that there was some correlation between having access to NASA materials and the attitudes of learning science. More research would need to be conducted to determine if the participants had the interest before coming to the summer program or if the summer program inspired them to choose a career in the space research field. Following are participant interview responses related to Research Question 7:

- Participant A: “If I had my dream job, it would be working for NASA designing space rovers that go across Mars, Venus, and other places.”
- Participant B: “Before I came to camp, I wanted to be an epilogist, someone who studies diseases. I now want to be a doctor that goes into space. That would be my dream job. The camp didn’t change my mind. I’ve always had the curiosity.”
- Participant C: “I want to be a computer engineer. I want to go to Virginia Tech and be on the Trek Team but since coming . . . here, I’m leaning towards space.”
- Participant D: “I want to become a robotics engineer. Learning here made me want to become a robotics engineer more because I learned about all the different jobs and how everyone has to work together to get things done.”
- Participant E: “I did enjoy robotics because we had a robotics class in my school and it has not changed since I [have] been here.”
- Participant F: “Aeronautical engineer or an astronaut. But since learning about space, I’m learning more about the astronaut side. I think that after a while of being around mechanical parts, I would get bored. As an astronaut, you are doing something different all the time.”
- Participant G: “Before I came to learn about space, I wanted to go into business and being here did not change my mind. I still want to go into business.”

- Participant H: “I want to become either a lawyer or a movie director. Learning about space did not change my mind about being involved in making movies.”

Research Question 8: Attitudes. This question, What extent does the use of NASA-designed educational materials significantly improve the attitudes of middle school students towards science? can only be answered through a culmination of all combined data; therefore, it is not addressed in this section.

Qualitative Data From Journal Entries

The purpose of having the participants maintain a journal through their NASA summer program experience was for gathering insight into the reflective process of the participants. The journal was used by the participants to connect their thoughts and feelings about their experience they were having. Through the analysis of the journal, patterns of information about the thoughts and feelings the participants experienced and to reveal the hidden assumptions and other important information were discovered. The journal entries were also used to verify the qualitative data.

Questions and responses to the journal entries include the following:

Journal Question 1: Describe how you interacted with the day’s activities. The purpose of this question was to measure the participants’ involvement in each of the activities. Tuan et al. (2005) reported that all students showed an increase in their ability to solve science problems and became more self-motivated. It provides students with more challenging and meaningful tasks are more motivated to learn.

The theme to all the responses revolved around engagement. Each participant documented how they interacted with a specific activity. Words used included helped, asking, and explored followed by a specific task or activity. The activities the participants described are the ones that were more challenging to them. Many students described how difficult it was to program robots but, as one participant wrote, “Enjoyed working on [the] group’s robot.”

Journal Question 2: How did you actively participate in the activity? The purpose of this question was designed as a follow-up and probe to the first question. The researcher was looking for more detail and specifics into the students’ participation in the activities. In this case, words and phrases such as listened, learned, contributed, and asked questions dominated the journal entries.

Journal Question 3: Explain how todays activities made you think about studying science in school. This question was designed to give the participants relevance and to make a connection between the activities being done and general science.

Keywords and phrases such as *fun*, *continue to study science*, *interesting*, and *enjoyment* dominated the journal entries. Evidence from the entries revealed that those who saw science as fun and interesting made claims that, as one participant wrote, “Science is an amazing subject.”

Journal Question 4: What activity would you identify as the most fun? This question was focused on determining if there was a correlation between the way the participants engaged in an activity and the activity itself. In other words, did they enjoy the more complex activities like the challenges compared to the easier activities like rocket building.

There appeared to be no correlation between one activity and another. The common denominator for having the most fun value was that it was hands-on.

Journal Question 5: What activity do you feel you learned the most? The purpose of this question was to determine if a participant can perceive an activity as both fun and have an educational value.

Responses from the journal entries showed no relationship between those activities the participants perceived as fun and those activities that were both hands on and highly interactive.

Qualitative data from the journal entries showed no evidence that middle school students attitudes significantly improved as a result of the intervention. Coding of the participants writing demonstrated that they were engaged with challenging tasks and enjoyed participating in the activities. The participants were not able to connect the fun activities to learning nor could they rate one activity to another as being more fun or interesting than the other. When asked if the intervention inspired them to consider pursuing science further, the consensus was that science is “fun,” “amazing,” and “interesting” but none of the participants shared any evidence that a change occurred in their attitudes towards science.

Chapter 4 Summary

Collecting data for this study was done through the TOSRA, a quantitative survey that measures the science attitudes of students. Qualitative data were measured through a face-to-face interview of a selected sample of participants who attended a NASA themed week long summer program. All of the participants contributed journal entries that assisted in bringing context to the quantitative data. The TOSRA determines the attitudes of students by measuring seven distinct characteristics of student behaviors. Very little evidence presented itself that would support the research questions. Integrating the qualitative and quantitative data lead to this conclusion and is discussed in Chapter 5.

CHAPTER 5. CONCLUSIONS AND DISCUSSIONS

Introduction

Students' attitudes, which include their interests and values, should be important to educators because these factors act as a powerful indicator of students' subsequent behavior (Popham, 2011). Positive attitudes toward any subject are frequently found to enhance students' interest and motivation to learn (Kara, 2009). To be successful as a learner of science, the learner must display a positive attitude as demonstrated by enthusiasm, a confident persona, with no episodes of anxiety about learning. It was hypothesized that improving attitudes toward the learning of science could improve student achievement, reduce science anxiety, improve motivation, enrich student understanding and use of technology, and help students become more self-directed learners. Because the attitudes one has toward learning inevitably influence the outcomes, the more positive attitudes one has, the better one performs in learning (Braten & Stromso, 2006; Duarte, 2007).

Although there is a considerable consensus of opinion that a positive attitude towards science brings about high achievement in science, these is confusion about the meaning of the *attitude to science*. Klopfer (1971) alleviated the semantic problems associated with the multiple meanings of the term "attitude to science" by providing a comprehensive classification scheme to narrow the focus of its meaning. Klopfer identified six manifestations that make up attitudes towards science. They include the manifestation of favorable attitudes towards science and scientists, the acceptance of scientific inquiry as a way of thought, adoption of scientific attitudes, enjoyment of science learning experiences, the development of interest in science and science related activities, and the development of interest in pursuing a career in science. Later, the manifestations attitudes towards science and attitudes towards scientists became separate measures. This study involved the use of NASA-designed educational material to determine if middle school attitudes towards science can be significantly improved. Chapter 5 provides a summary of the study, conclusions and discussion of results, implication for practice, and recommendations for further research.

The design selected for this study was an action research study with mixed methods research aimed to align with the research methodology. This study assessed the effects of student attitudes toward learning science utilizing educational materials developed by NASA of 30 secondary school students from different geographical areas of the United States. Participants of this study began by taking the TOSRA to determine levels of attitudes using their original educational institution as a baseline of data. The intervention used was materials developed by educational experts from NASA. This material was of thematic design incorporating history, math, technology, engineering, science, and art. To assist in the interpretation of the quantitative data collected, the participants were asked to give qualitative feedback in the form of journal writing activity at the end of each intervention day. After the intervention, the participants were given the same TOSRA as a posttest data collection instrument and a small sample of the group was asked to be interviewed. The data from the pretest, posttest, journal samples and interviews were used to make conclusions.

This study used both a qualitative and quantitative comparative design. In this study, the TOSRA was used to measure quantitatively the manifestation of favorable attitudes toward science and scientists by measuring seven subcategories (Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure in Science, and Career Interest in Science). Scales from the TOSRA were used in the data to determine the statistical significant of the null hypothesis in each domain. The statistical alpha level was set at $p < 0.05$ for all groups to determine the null hypothesis. Quantitative descriptive statistical data were used to describe each variable's mean, standard deviation, and significant difference and to answer the research question. Percentages and frequencies were calculated for nominal data and means. Standard deviations were calculated for continuous data.

The interview was used as a means to collect the qualitative data to capture the perspective of the participants after the intervention and help answer the question. The interview was selected for the opportunity to follow up on any interesting comments the participants may want to provide. The structured interview format was used to obtain answers from carefully phrased questions to insure uniformity of the questioning. Eight participants were chosen by random through a computer number random application.

After the interviews, they were transcribed. Through open coding methods, themes, recurring ideas, and patterns of beliefs were identified.

At the end of each day, the participants were asked to make an entry in a journal documenting their experience. Journal entries by the participants was used as a medium in which to determine the level of participation in the study. It was also used to bring meaning to the quantitate data collected provided by the TOSRA.

Summary of Results

Research has shown that by the age of 14 a student would have made up their mind as to whether to continue the study of science or pursue a career in the science field (Osborne et al., 2003). Research also shows that some of the reasons students lose interest because they see no relevance in their personal lives, are disengaged with the classroom curriculum, and experience a lack of innovative teaching strategies (Millar & Osborne, 1998). NASA-developed educational materials can fulfill these requirements in the classroom.

The relationship between student attitudes of science and NASA educational materials were explored using the TOSRA for the collection of quantitative data and interviews and journal readings of qualitative data gathering. The TOSRA is an instrument designed to measure the manifestations of the attitudes of secondary school–aged students. They include the Social Implications of Science, Normality of Scientists, Attitude of Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. The 70 questions are divided equally into the seven categories of the survey. Each of the 70 questions of the

TOSRA are Likert-type scales that determines the varying degrees of agreeability of each survey question. Once each category received a quantitative value, a *t* test was used to determine the significant difference or whether the null hypothesis was accepted or dismissed. Qualitative data analysis in the form of interviews and journal entries by the participants was used to help explain the quantitative data gathered by the TOSRA.

To determine the extent that NASA-designed educational material improve the attitudes towards science by middle school students, through the use of the TOSRA all seven of the manifestations that make “attitudes of science” was analyzed individually. The seven categories of the TOSRA inspired additional questions concerning the effect of NASA-designed educational materials substantially improving the attitudes of middle school students towards science. The quantitative component of this study was guided by eight research questions:

1. To what extent does using NASA-developed educational material significantly improve middle school student’s attitudes towards science?

    - $H1_0$: Using NASA-developed educational material will not significantly improve middle school student’s attitudes towards science.

    - $H1_A$: Using NASA-developed educational material will not significantly improve middle school student’s attitudes towards science.

2. To what extent does using NASA-developed educational materials significantly improve the attitudes of middle school students toward the areas of social benefits, positives, and negatives on scientific progress and scientific research?

    - $H2_0$: Using NASA-developed educational materials will not have a significant improvement on the attitudes of middle school students toward social benefits, positives, and negatives on scientific progress and scientific research.

    - $H2_A$: Using NASA-developed educational materials will have significant improvement on the attitudes of middle school students toward social benefits, positives, and negatives on scientific progress and scientific research.

3. To what extent does using NASA-developed educational materials have a significant improvement on the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles?

    - $H3_0$: Using NASA-developed educational materials will not have a significant improvement on the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles.

- $H3_A$: Using NASA-developed educational materials will have a significant improvement on the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles.

4. To what extent does using NASA-developed educational materials significantly improve the attitudes of middle school students as to the way they see the scientific method of inquiry as a valid way of thinking and that approaching a problem or situation?

   - $H4_0$: Using NASA-developed educational materials will not have a significant improvement on the attitudes of middle school students have on the way they see the scientific method of inquiry is a valid way of thinking and that approaching a problem or situation.

   - $H4_A$: Using NASA-developed educational materials will have a significant improvement on the attitudes of middle school students have on the way they see the scientific method of inquiry is a valid way of thinking and that approaching a problem or situation

5. To what extent does using NASA-developed educational materials significantly improve the attitudes of middle school students toward scientific curiosity and openness to scientific interpretation?

   - $H5_0$: Using NASA-developed educational materials will not have a significant improvement on middle school students' attitudes toward reversing their opinions on scientific investigations and inquiry and how likely they will change their way of seeing their environment after confronted with scientific evidence.

   - $H5_A$: Using NASA-developed educational materials will have a significant improvement on middle school students' attitudes toward reversing their opinions on scientific investigations and inquiry and how likely they will change their way of seeing their environment after confronted with scientific evidence.

6. To what extent does using NASA-developed educational materials significantly improve the attitudes of middle school students toward the enjoyment of science lessons?

   - $H6_0$: Using NASA-developed educational materials will not significantly improve middle school students' attitudes toward the enjoyment of science.

   - $H6_A$: Using NASA-developed educational materials will significantly improve on middle school students' attitudes toward the enjoyment of science.

7. To what extent does the use of NASA-developed educational materials significantly improve middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom?

    - $H7_0$: Using NASA-developed educational materials will not significantly improve on middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom.

    - $H7_A$: Using NASA-developed educational materials will have a significant improvement on middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom.

8. To what extent does using NASA-developed educational materials significantly improve the attitudes of middle school students toward pursuing a career in science?

    - $H8_0$: Using NASA-developed educational materials will not have a significant improvement on middle school students' attitudes toward pursuing a career in a science field.

    - $H8_A$: Using NASA-developed educational materials will have significant improvement on middle school students' attitudes toward pursuing a career in a science field.

Discussion of the Results

The quantitative data were retrieved from the TOSRA, a survey that assesses the students' attitudes toward science based on the seven manifestations that make up one's attitude. The research questions are based on each of the seven manifestations.

Fraser's (1981) Test of Science Related Attitudes (TOSRA) includes 70 items, each measured on a 5-point *Likert* scale; these items comprise seven subscales with 10 items each. The responses scale ranges from strongly agree (1) to strongly disagree (5).

Out of the 10 survey questions, five are designed as positive response and five are negative with their position on science and science-related issues.

The TOSRA was given twice, once as a pretest and once as a posttest. After all 30 participants took the TOSRA pretest, a mean score was calculated for each question.

Each question was then categorized according to the TOSRA scale allocation and scoring sheet provided by the TOSRA scoring sheet (Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science).

The mean of each of the questions within the specific category was calculated then the standard deviation was identified. The mean of standard error was determined by using the standard deviation using the Microsoft 2112 Excel software. By dividing the mean difference from the standard error, the *t* statistic was determined. Comparing the *t* statistic to the *t* table from San Jose State University (Gerstman, 2007), the significance level for each category was determined. Significance levels most commonly used in educational research are the .05 and .01 levels. The figure .05 implies that 95 out of 100 times, the results will favor a specific side from the population surveyed.

The first method used to collect the qualitative data was a face-to-face interview with a small sample of participants. Prior to the interview, each student was given a number based on their position on the enrollment records. The executive director of the summer program used a random number selector application on a cell phone to choose eight numbers. The participants selected were all given permission by their parents to participate in the interview process.

The interview took place in cafeteria setting with the executive director present per the organizations child safety plan. All questions and responses were audio taped for accuracy during the transcript assembly process. All the participants appeared before the interviewer to be timid and shy through the interview process. Each interview lasted approximately 10 minutes to give each interviewee a chance to collect thoughts before answering. No follow-up questions were asked for fear of maneuvering statements toward a more favorable or misspoken response. None of the interviewees were compensated in any way for the interview.

The analysis method used was a thematic coding process. This is a process in which the researcher can alter and modify the analysis as interpreted by the data as new ideas emerge. Taken directly from the audio taped interviews, the recordings of each of the eight interviews were transcribed. Because the data from the interviews were divided into seven different themes, each theme was analyzed separately and compared to analyzing each interview while looking for themes. The next step involved coding all the data by hand, color coding keywords and concepts that captured the qualitative value of the phenomenon. Coding for consistency, validation, and outliers that were analyzed and eliminated from the data. From the coding, themes, subthemes, and specific patterns by vocabulary and conversation topics were isolated. Lastly, descriptions and quotes from each theme were finalized to help communicate its meaning to the reader.

The interview questions were developed for this study and were field tested by panel of experts to determine if each was appropriate to the study and to secondary school–aged students. The questions had a direct relationship to each of the seven manifestations of overall student science attitudes.

The purpose of having the participants maintain a journal through their NASA summer program experience was to gather insight into the reflective process of the participants. The journal was used by the participants to connect their thoughts and feelings about their experience they were having. Through the analysis of the journal, patterns of information about the thoughts and feelings the participants experienced and to reveal the hidden assumptions and other important information were discovered. The journal entries were also used to verify the qualitative data.

Research Question 1. Research Question 1 was, To what extent does using NASA-developed educational material significantly improve middle school student's attitudes towards science?

To answer this research question, many things had to be taken into consideration. The quantitative data from the TOSRA and the qualitative data from interviews and journal entries. Also considered was the current literature and the sample used for this action research project.

The TOSRA is a survey that assesses students' attitudes toward science. There are seven manifestations that determine the totality of students' attitudes toward science. They include Social Implications of Science, Normality of Scientists, Attitude Toward Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. The use of face-to-face interviews and journal writing entries from the participants was used to either argue or support the results from the qualitative data collected from the TOSRA. Both the interview questions and the journal prompts were designed to reflect the survey questions of the TOSRA. This allows for the participants to expound on each of the manifestation categories of the TOSRA. Once the interviews were transcribed both the transcripts and the journal writings were analyzed through a coding design method that identified themes and commonality.

Out of the seven manifestations that make up the attitudes of middle school students towards science, five of them show promise that the NASA developed educational materials would have a significant improvement. Two of them, normality of scientists and science inquiry, did not show that they significantly improved middle school student's attitudes towards science.

During the summer program, the participants were asked to keep a daily journal related to their experience. These journal entries were codes for themes and patterns that coordinate with the quantitative data results and the interview results. Entries related toward being engaged with the lesson were positive and meaningful. Words like *fun*, *enjoyment*, and *interesting* were used to describe the activities. One entry from the journal responses echoed the theme: "I had so much fun and learned so much. I did so much stuff here than I could have ever done in school." When asked if the intervention inspired them to consider pursuing science further, the consensus was that science is "fun," "amazing," and "interesting" but none of the participants would share any evidence that a change has occurred in their attitudes towards science. The journal entries used in this study concluded that the NASA materials used did not have a significant improvement on the attitudes of students learning science.

Research Question 2. Research Question 2 was, To what extent does using NASA- developed educational materials significantly improve the attitudes of middle school students toward the areas of social benefits, positives, and negatives on scientific progress and scientific research?

The first of seven categories found in the TOSRA is the Social Implications of Science. The Social Implications of Science scales is a measure of the favorable attitudes toward science that includes the attitudes toward social benefits, positives, and negatives on scientific progress and research (Fraser, 1981, p. 2). It is a belief that science plays a major role in solving social problems through research and development of new technologies. Table 5 is the descriptive statistics table containing the data from the Social Implications of Science category of the TOSRA. It represents the quantitative results from tabulating the 10 questions that relates to the social implications of science from the 30 participants. To put this category into context, this researcher posed a question that guided the data collection.

The findings, as indicated by the quantitative data results, suggested that there is some significant difference between the attitudes of middle school–aged students using NASA-designed educational materials and those who use traditional curriculum. Based on the quantitative results of this study, the manifestations that are effected by the use of NASA-developed education materials are normality of scientists and attitudes of scientific inquiry. The other five manifestations within the TOSRA indicated that NASAdesigned educational materials have no effect on middle school–aged students' attitudes toward science.

The first question, a component of the TOSRA, was sought to determine if there was a significant improvement in the way the participants view science and society preintervention versus postintervention. The *t* test was used to analysis this question and to provide evidence to justify the findings. The *t* test failed to provide the evidence to support the hypothesis that NASA educational materials do have an effect on students' attitudes toward science. After analyzing the 10 questions relating to the social implications of science from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was 1.92, which is greater than .05, the significance level used in education. Based on the quantitative data, the null hypothesis could be rejected. Therefore, based on the evidence, NASA educational materials would have a significant improvement on the attitudes on social implications of students learning science with NASA-designed materials and is not a manifestation of helping to effect students' attitudes toward science.

To confirm or to argue quantitative results, interviews with the program participants was conducted. The interview question related to research question 1 was asked: After participating in this camp, how important do you think science is toward improving the lives of people on Earth? Can you give an example? Coding revealed that the participants understood the importance of science in society. Every interviewee inferred that science helps solve earth's problems or help prevent problems on Earth. Throughout the summer program experience, students were exposed to the social implications of science that may or may not have influenced their response to the interview question. The social advantages and benefits of exploring space is highlighted in the intervention used in this study. It is also contained within the educational materials and reinforced in the guided NASA tours that the students partook.

One of the tour stops was the opportunity to be briefed by a NASA scientist/pilot who explained how his flights were designed to benefit mankind. It was difficult to determine, based on the interview responses if the participants came to their responses prior to participating in the summer experience or the exposure they had experienced changed their position on science in society. More research will be needed to answer the question as to whether students come to a science-themed program understanding that science impacts society's role on Earth.

Research Question 3. Research Question 3 was, To what extent does using NASA- developed educational materials have a significant improvement on the attitudes of middle school students on the way they perceive scientists as individuals and their lifestyles?

The second category of the TOSRA addressed the Normality of Scientists. This component of the TOSRA was to determine the significant difference in the way the participants view scientists pre-intervention and postintervention. The *t* test was used to support for or against the null hypothesis. After analyzing the 10 questions relating to the way the participants view scientists, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was −0.43, which is less than .05, the significance level used in education. Therefore, the null hypothesis is accepted based on the quantitative data of the TOSRA. The use of NASA educational materials does not have a significant improvement on the way the participants perceive scientists.

Qualitative data analysis of this category revealed that the participants had many misconceptions about scientists and what they do. According to the coding results, the participants carry many misconceptions about how scientists live and work. The theme of this response can be echoed by Interviewee Participant B, who stated,

> Most of them work at a school or college. They don’t make much money so they are allowed to live in rooms at the school. They know how to solve a lot of problems with their knowledge of math and other subjects.

The interviews revealed that they still have stereotypical opinions that involve large laboratories with test tubes and fire. They do not believe that scientists have families and do activities outside of the lab. They think that scientists are very smart and their hobbies involve conducting experiments. The only conclusion to make is that the qualitative data and the qualitative data support each other.

Research Question 4. Research Question 4 was, To what extent does using NASA- developed educational materials significantly improve the attitudes of middle school students as to the way they see the scientific method of inquiry as a valid way of thinking and that approaching a problem or situation?

The third category of the TOSRA dealt with scientific inquiry**.** This component addresses attitudes of middle school–aged students toward science is scientific inquiry preintervention versus postintervention. The *t* test was used to analysis this question. After analyzing the 10 questions relating to the attitudes toward scientific inquiry from the TOSRA, using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was −2.12. This equals to a $p < .05$ that the null hypothesis would be accepted. Therefore, based on the qualitative data collected through the TOSRA, NASA educational materials would not have a significant improvement students' attitudes toward their perception of scientific inquiry as the null hypothesis is accepted.

To verify or discredit the results from the TOSRA, the following interview question was asked: Scientific inquiry means that you learn and understand science by using the same procedures or steps true scientists use. In your opinion, is it a good or bad way of learning science? Explain in your own words.

Analysis of this question uncovered that many of these participants did not understand the purpose of the scientific method of inquiry. Many of the responses inferred that the method of scientific inquiry was a way of learning science and not a way of solving problems through steps and procedures. The theme of these responses were similar to those of Interviewee Participant A, who said, "I think there are other ways to get answers to what we want to know. I wouldn't use the scientific method because there are [*sic*] more than one way to do an experiment." Their belief is that there are many ways to conduct a scientific experiment to solve a problem. Only a small percent of the participants made reference to answering a scientific question through the steps of the scientific method. Without researching into the pedagogy of the participants' scientific background, it is impossible to determine if middle school–aged students truly understand the scientific method. It was determined that the results of the qualitative data supports the quantitative data results.

Research Question 5. Research Question 5 was, To what extent does using NASA- developed educational materials significantly improve the attitudes of middle school students toward scientific curiosity and openness to scientific interpretation?

The fourth category from the TOSRA addresses scientific attitudes. This question was used to determine if there was a significant difference in the way middle school students adopt scientific attitudes. It provides a better understanding of how the participants look at new scientific evidence and whether their opinions can be changed based on the empirical evidence. Microsoft Excel was used to make an analysis of the 10 questions supporting the TOSRA category. The *t* test provided evidence that the null hypothesis is rejected. It was found that the *t* statistic, 0.5, was greater than the .05 significance level used in education. Based on these findings, the null hypothesis is rejected and determined that the intervention would significantly improve middle school students' scientific attitudes toward the adoption of science openness.

The question posed to the participants was, there are times at school or at home when you are given information from someone but it doesn't make sense to you. How do you handle such situations? This question was designed to determine if the participants would accept new theories provided by science. Because NASA materials are kept current with up to date information, sometimes with real time data, and they have access to many electronic resources, therefore, it can be inferred that the participants are open to new scientific theories and discoveries. This would be a contradiction to the results of the quantitative data. Many of the participants admitted to using online resources to answer scientific questions. Other studies may have to be conducted to determine whether the participants truly accept the theories that website resources provide or either the qualitative data or quantitative data are an outlier.

Research Question 6. Research Question 8 was, To what extent does using NASA- developed educational materials significantly improve the attitudes of middle school students toward the enjoyment of science lessons?

Enjoyment of science lessons involve all aspects of learning science. It is the way students involve themselves and the way science is presented that enables them to engage in science-related discussions and sharing conflicting ideas (Klopfer, 1971, p. 578). It means that a student enjoys science in either a formal educational institution or an informal setting. After analyzing the 10 questions relating to the enjoyment of science lessons from the TOSRA, using Microsoft Excel to calculate the t statistic, it was found that the t statistic is 2.45, or $p > .05$. Based on the quantitative data, the null hypothesis is rejected. It can be concluded that the use of NASA-designed education materials significantly improve middle school students' attitudes of the participants' enjoyment of science.

The supporting interview question based on the Enjoyment of Science category within the TOSRA was, If I asked you to rate how much you like general science on a scale from 1 to 5, 1 being a big dislike and 5 a huge liking, what would that number be? Why did you choose that number? After coding the responses then analyzing the themes and patterns presented, results showed that most of the participants chose the numbers 4 or 5, 5 being most enjoyable and 1 being the least. Themes uncovered were future benefits science will bring, science being fun, and students always having liked science. Those who chose lower numbers did so because of the math or subjects that support science. It is undetermined if the participants interpreted the phrase enjoyment of science as fun with science. Whether enjoyment of science means fun or another analogy, it can be concluded that the NASA-designed educational materials support both the qualitative and quantitative results that students' attitudes toward science are affected when the NASA materials are introduced as pedagogy.

Research Question 7. Research Question 7 was, To what extent does the use of NASA-developed educational materials significantly improve middle school students' attitudes toward the enjoyment of science as a hobby outside the classroom?

NASA educational materials had an effect on the participants' interest in science as a hobby pre-intervention versus postintervention. Using Microsoft Excel to calculate the t statistic from the 10 questions within the leisure interest in science, it was found to be 3.92, or $p \geq 0.5$, the significance level determined for education. It can be concluded that the null hypothesis is rejected or that NASA educational materials would have an effect on students' attitudes toward the leisure interest in science.

Qualitative interview questions were designed to determine if there appeared to be a correlation with the quantitative date. The question was, Your parents want your input on the next summer vacation. They just announced to you that you will be going to Florida, home of Disney World, Sea World, Kennedy Space Center, white sandy beaches, and many historical places. How would you like to spend your summer vacation while in Florida? Where would you go? What would you do? What would you like to see? Put them in numerical order from the most important to you to the least.

After coding the transcripts from the interview questions, it can be concluded that no patterns or themes dominated the responses. The diversity of how the participants like spending their leisure time was just as diverse as the participants themselves. Therefore, the determination of whether the participants' leisure in science attitude was affected by the use of NASA-designed educational materials is inconclusive.

Research Question 8. Research Question 8 was, To what extent does using NASA-designed educational materials significantly improve the attitudes of middle school students toward pursuing a career in science?

This category sought to determine if there was a significant difference between preintervention and postintervention thoughts of the participants choosing a science career after using the NASA educational materials. Analysis of the 10 questions within this category was done with the *t* test to justify quantitative findings. The *t* test failed to support the hypothesis that the NASA educational materials were a catalyst in the participants' decision to choose a science field career. Using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic was 2.12, which is greater than .05, the significance level used in education. Therefore, the results of the *t* test revealed that the results do not support the null hypotheses and that the use of NASA educational materials does have a significant effect on the decision of the participants to pursue a future career in the science field.

Qualitative analysis was performed through coding to identify themes and patterns emerging from the transcripts addressing the career in science category of the TOSRA. The question posed for this category was, what occupation do you want to be involved in when you grow up and become an adult? Analysis of this interview question provided no evidence that the use of NASA-designed educational materials had an effect on the decision of the participants to pursue a future career in science. More research would need to be conducted to determine if the participants had the interest before coming to the summer program or if the summer program inspired them to choose a career in the space research field.

Discussion of the Results in Relation to the Literature

Attitudes are the internal beliefs that influence actions that radiate out as ones generosity, honesty and the commitment to healthy living (Schunk, 2008). They are inferred through many characteristics because they cannot be directly observed or measured easily. There has been found a direct link between student achievement and student attitudes toward science. According to researchers, attitudes influence outcomes and the better the attitude the high the achievement in learning, which is the purpose of this study. Attitudes have been shown to have an influence on outcomes and the more positive the attitude, the better one performs in learning (Braten, 2006; Duarte, 2007).

Attitudes are learned indirectly through experiences and exposure to external factors such a television or negative environments (Gagné, 1984). Positive attitudes displayed as confident, enthusiastic, a display of no anxieties and positive expectations from experiences is needed in order to succeed in learning about it (Başaran, 1974).

Adventures of both manned and unmanned space flight has generated interest to both the old and young alike. Young people are beginning to be attracted to science, technology, engineering, and math (STEM) careers which is the catalyst for a need of specific aeronautical curriculum (Dick & Launius, 2007). Through the use of thematic or mission-specific subject matter, NASA provides educators with materials that enhance the student skills with fun, collaborative and challenging activities (NASA, 2007).

Textbooks, lesson plans, and laboratory and modeling activities related to the latest exploratory mission are included within the materials NASA provides. In this study, the combination of fun and challenging activities along with the interest of space exploration did not improve the attitudes of students learning science.

Positive attitudes are demonstrated by the students if they enjoy the subject, have teacher support and show no signs of frustrations as they encounter new material (Schweinle, Meyer, & Turner, 2006). The data from this study shows a consistent result. Coding of the qualitative data of the revealed keywords and phrases including fun, continue to study science, interesting, and enjoyment dominated the journal entries. During interviews, the participants were asked, how much do you like general science on a scale from 1 to 5, 1 being a big dislike and 5 a huge liking, what would that number be? Why did you choose that number? Analysis through thematic coding of this question revealed that those who chose the numbers 4 or 5 like science because of the future benefit science will bring, it is fun, and they always liked it. Although the data suggests the participants enjoyed and had fun during the intervention, more research will be needed to determine levels of student enjoyment of science prior to the intervention to make a better determination. The qualitative results verified what the quantitative results showed. Using Microsoft Excel to calculate the *t* statistic, it was found that the *t* statistic is .03, or $p < .05$, or that the null hypothesis is rejected and that NASA educational materials would have a significant improvement on attitudes toward the enjoyment of science lessons.

Descriptive statistics was conducted to ascertain information about the attitudes of middle school students learning science by using NASA-developed educational materials.

Inferential tests were carried out to obtain data in order make generalizations about the science attitudes of middle school students in relation to NASA-developed educational materials. Results from both descriptive and inferential statistical data were found to be both inconsistent with the theoretical framework highlighted and the literature reviewed in this study.

Based on the quantitative and qualitative data collected, it can be concluded that using NASA-designed educational materials does not significantly improve middle school–aged students' attitudes toward science, even when the materials are designed under a constructionist framework. This conclusion is inconsistent with the current literature available that revolves around the theoretical framework of the study.

Pedagogical constructivism is an active process in which students are taught to construct their own understanding rather than rely on the instructor to disseminate knowledge (Bryant et al., 2013). The most common manifestation of constructivism in science education is what is called interactive engagement, a push away from traditional teacher–student lecture interaction. NASA educational materials are based on constructionist pedagogical practices.

Relationships between science learning attitudes has been explored in only a few research studies. The research does show a correlation between positive attitudes in science and achievement in science courses. Literature indicates that attitude improvements does occur when the student gets personal support and experiences a variety of teaching strategies, innovated learning activities, and student-centered designs (French & Russell, 2006; Osborne et al., 2003; Wolf & Fraser, 2008). The NASA engineering design challenge: Thermal protection systems is a model that demonstrates these classroom characteristics that improve student attitudes toward science. In this challenge, the teacher is a facilitator and the students take control over their own learning through the design process, engineering process and testing phase of a reentry system of a spacecraft as it enters the atmosphere (National Aeronautics and Space Administration, n.d.). Results from this study shows an inconstancy with the literature. Although NASA provides the elements to improve student attitudes indicated in the literature, the data within this study failed to support this fact. One of the practices that support the constructionist theory is project-based learning. It requires learners to construct knowledge through activities that support learning and not memorization. It is the foundation of constructivist theories that that make project-based learning possible for student to collaborate with others in comparative learning experiences (Jonassen & Grabowski, 2003; Knoll, 1997).

Limitations

Limitations of this study was due to time constraints placed by the research site and performance of the personnel. The participants of the research site program were on a strict time schedule, and therefore, the planned activities related to this study were divided into sessions not recommended in the NASA materials. Because this researcher intent was to separate himself from the NASA activities as to not introduce bias, he did not monitor the delivery of the activities and solely relied on the commitment each instructor pledged to this researcher.

Implication of the Results for Practice

The results of this study are aimed at the heart of education, the attitude of the learner. The information gained through this research study will add to the knowledge base concerning the effectiveness of the educational materials, provided by NASA, on improving students' attitudes toward science. Although NASA was chosen to be the medium in which to conduct this particular study, there are many other organizations that have a particular niche in which to distribute knowledge.

The use of NASA-developed educational materials in the classroom has some promise to improve students' attitudes about learning science. Evidence through this study points to a positive impact on student attitudes when comparing postintervention to preintervention and the way NASA-developed educational materials influence the way they feel about scientific inquiry and the normality of scientist.

Other components within the study can have implications for effective best practices. Thematic instruction, a practice embedded in the NASA curriculum, is a way that curriculum is organized around specific macrothemes. It involves the integration of basic disciplines like science, math, and reading to explore a broad subject. Arguments have been made that there are positive effects using integrated curriculum. Although not much research has been done comparing traditional versus thematic instruction, a study was carried out in the Nigde province of Turkey in 2001-2002 that showed a significant difference between the controlled group and the experimental group when achievement and attitudes were measured (Baş & Beyhan, 2012) in favor of thematic instruction.

NASA incorporates the basic disciplines in each of its designed educational materials. Not only is STEM integrated but also social studies and arts can be found in the material. It incorporates subsets of the constructionist theories using STEM-based engagement activities designed to connect the learner with unique space exploration missions and resources through participatory and experiential learning activities (NASA, 2015a). The educational materials consist of elements of discovery, problem solving, and cooperative learning. As students' progress through the materials, they do so in teams to research and complete tasks, test theories, and come up with satisfactory and effective solutions to the challenges that make learning relevant as they recognize the link between their lesson and the learning objectives (Rockland et al., 2010). Through the scientific inquiry process students are taught to think like a scientist through critical thinking and reasoning as they conduct research, test ideas and discover new concepts (Rockland et al., 2010). The components of NASA-designed educational materials can also be applied to other science-based organizations that offer educational materials to academic institutions. All of these variable practices contribute to improving the attitudes of students towards science.

Recommendations for Further Research

The data collected during this study provided a foundation for further research on whether NASA-designed educational materials improve the attitudes of students learning science in secondary schools. It was clear that the students enjoyed the materials as it was presented during that small period of time but the main research question still remains. The study took place at a summer camp in which NASA-designed educational materials are used exclusively and supported by a NASA. Research is needed to eliminate all other factors that contributed to a change in the attitudes of students using NASA educational materials.

A longer exposure to the materials must be implemented before an accurate research-based conclusion can be drawn. It is speculated that one week of aerospace activities might not be enough time to gather valid data. Research using a larger population that includes representation of all demographics, and not just those interested in aerospace, will also need to be conducted to provide focus on the effects of NASA materials on a more diverse population. Repeating this study is also recommended at a research site that is not associated with a NASA facility.

According to the literature found, or lack thereof, there should be more research on the attitudes of secondary school students learning science in general. Attitudes have shown to have an influence on outcomes and the more positive the attitude, the better one performs in learning (Braten & Stromso, 2006; Duarte, 2007).

Characteristics of successful leaners are confident, enthusiastic, display no anxieties and have positive expectations from it. Attitudes have been shown to have an influence on outcomes and the more positive the attitude, the better one performs in learning (Braten & Stromso, 2006; Duarte, 2007). If one is to believe a positive attitude toward any subject is needed in order to succeed in learning about it (Başaran, 1974), one must invest in further research of relationships between what changes students' attitudes and learning.

Conclusion

A direct link between high student achievement and a positive attitude that is displayed in the classroom environment and the teacher's pedagogy has been found using research practices (French & Russell, 2006). It has also been found that students with a positive attitude toward science and scientists will participate more in class and show an increased interest in science and, therefore, will have more positive views of science and will entertain future career of science (Jarvis & Pell, 2005). The use of NASA-developed educational materials in the classroom has some promise to improve students' attitudes about learning science.

The TOSRA was designed to analysis seven characteristics that middle students have that determines their attitude toward science. Evidence through this study points to a positive impact on student attitudes when comparing postintervention to preintervention and the way NASA-developed educational materials influence the way they feel about scientific inquiry and the normality of scientist. The NASA materials intervention exposed students to the different careers in the aerospace industry, the people who are conducting real-life science application experiments that have meaning and they learned in a cooperative environment with students who have the same interest.

The support from the category of scientific inquiry and norms of a scientist can be explained by the quantitative data. Traditional science learning often consists of lectures and the memorization of facts and strange words, which leaves no time to conduct experiments that can show the benefits of using the scientific method of inquiry (Marincola, 2006). Studies have also indicated that a positive attitude toward science and scientists can influence views of science, future career awareness, and classroom participation (Jarvis & Pell, 2005). Rarely are students exposed to the life of a scientist but during this study, students had unlimited access to scientists.

NASA-designed educational materials are derived from the different branches of constructivist theories. According to some studies, "constructivist learning approach has a positive effect on learners' academic success, retention and attitude scores" (Semerci & Batdi, 2015, p. 171). The results of this study yielded information and data that could be useful in determining what is needed to improve the attitudes of secondary school students toward science. Unfortunately, due to the many constraints placed on this study and based on the results, much more research is needed to determine whether the use of National Aeronautics and Space Administration designed educational materials significantly improves the attitudes of middle school students towards science.

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STATEMENT OF ORIGINAL WORK

Academic Honesty Policy

Capella University’s Academic Honesty Policy (3.01.01) holds learners accountable for the integrity of work they submit, which includes but is not limited to discussion postings, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person’s ideas or works.

The following standards for original work and definition of *plagiarism* are discussed in the Policy:

> Learners are expected to be the sole authors of their work and to acknowledge the authorship of others’ work through proper citation and reference. Use of another person’s ideas, including another learner’s, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct. (p. 1) Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else’s ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium. (p. 2)

Capella University’s Research Misconduct Policy (3.03.06) holds learners accountable for research integrity. What constitutes research misconduct is discussed in the Policy:

> Research misconduct includes but is not limited to falsification, fabrication, plagiarism, misappropriation, or other practices that seriously deviate from those that are commonly accepted within the academic community for proposing, conducting, or reviewing research, or in reporting research results. (p. 1)

Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature

I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including the Policy Statements, Rationale, and Definitions.

I attest that this dissertation or capstone project is my own work. Where I have used the ideas or words of others, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA *Publication Manual*.

Learner name and date: George Peter Fatolitis, 5/2017