ARTS – INSPIRED STUDENTS SYNC THEIR ASSETS TO A NUTS & BOLTS WORLD
(A CAREER MENTORING PILOT PROGRAM)

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Dedication and Acknowledgments

This work is dedicated to Amanda Johnson, Creola Johnson Moore, Sarah Johnson Barber, Dr. Roy Douglas Moore, Dr. Eva Val. Moore and Sarah Moore Coleman, triumphant educators upon whose shoulders I stand.

Thank you God for bringing this opportunity my way. I hope I will be used as an instrument to do that which you deem needed and necessary to help encourage and strengthen our youth.

Special thanks to my family for your love and support, Sarah M Coleman, mom, L.C. Coleman, dad, Alvin “AJ” Hudson II, son, Brooke C. Ross, daughter, and grandchildren Jaylen Ross, Myles Ross, & Alvin “Trey” Hudson III, Marcus Ross, son-in-law, and Jessica & Heaven Walls.

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Abstract

This research examined how students who are arts-inspired feel about their futures in a STEM-based work climate. Science, Technology, Engineering, and Math are the nuts and bolts, and in education today, the only avenue touted for our country and our students’ success in this 21st century economy. This can be disconcerting to those interested in other fields, like the arts. This study was guided by the following questions in an effort to understand if our artists and arts-inspired students realize their options and importance in this 21st century climate. The pilot study was designed to help improve the students’ perception of their abilities or self-efficacy in the STEM areas by introducing STEM professionals as mentors who designed hands-on activities that simulate work in the STEM fields.

Research Questions:

1. Do arts-inspired students have an interest in a STEM career area prior to participating in the career mentoring program?
2. Does participation in a STEM career mentoring program improve student’s self-efficacy in STEM fields?
3. Does participation in STEM career mentoring program increase student’s interest in pursuing STEM-related careers?

Lent, Brown and Hackett’s Social Cognitive Career Theory and Daniel Pink’s, “A Whole New Mind: Why Left-Brainers Will Rule the Future” were used as the theoretical framework for this study. Seventeen African-American girls who were enrolled in the “I AM COMPLETE” summer program participated in the pilot study. Data was collected from the College Foundation of North
Carolina Career Interest Explorer and the STEM Career Interest Survey, which served as a pre and post-test.

This pilot offered limited support for the hypothesis, however, career mentoring and opportunities for young people to experience careers, especially in the STEM areas must continue to grow. The role that the arts play in this process is pivotal in galvanizing females and minorities to join these professions. It is the hope of this researcher that the pilot be replicated using a much larger population of students and school communities.

**Keywords: Self-Efficacy, STEM, STEAM, College and Career Ready**
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Chapter One: Introduction

Purpose of the Study

The purpose of this study was to design a pilot program that will address the need for females interested in the arts to pursue careers in Science, Technology, Engineering, and Math (STEM). The Arts served as a catalyst in helping students become interested in these career areas and feeling that they can be successful professionally in them. The interventions that moved students from a place of uncertainty to a place of confidence were hands-on activities that assimilated operations in the various fields. These activities were designed and facilitated by professionals in the field who served as career mentors to these students. Roundtable discussions and “New Mind” activities help link the arts foundation that the students possess with the technical applications that the students experience experientially.

After consulting with the director of the I Am Complete summer camp for girls about ways in which she could enhance and bring some dynamic offerings to the girls at her camp, I realized that her camp would be the perfect place to pilot this study. The demographics at the camp are appropriate, when looking at the trends, since minority females represent the lowest percentage of students making STEM careers a choice. This pilot has the capacity to be a prelude to a larger study, which would explore possibilities for students at the three arts magnet schools in the Charlotte-Mecklenburg Schools System and have those arts-inspired students participate in a program with mentors and activities that would heighten their awareness about what is possible for them in the STEM areas.
Arts Magnet Schools in Charlotte

University Park Creative Arts Elementary, First Ward Creative Arts Elementary, and Northwest School of the Arts are full visual and performing arts magnet schools in Charlotte, North Carolina. University Park and First Ward serve students in kindergarten to fifth grades and Northwest is the middle and high school feeder school. These schools are a part of the A+ Schools Program of the North Carolina Arts Council, which is the largest, longest running, most successful arts-based whole-school reform effort in the nation (http://aplus-schools.ncdcr.gov). University Park’s tag line is “Arts + Academics = Success”, and the vision states that, "Through the arts, students will be inspired to become creative problem solvers, productive citizens, and life-long learners."

Arts integrated learning is at the core of what these arts schools and the A+ Schools Program are all about. The arts are essential to teaching and learning in all subjects, aiding in developing creative, innovative ways of thinking and fostering meaningful, enjoyable, engagement. Students at the creative arts magnet schools study visual and performing arts in addition to their arts integrated core curriculum. As Rosiland Lackey, original Principal of University Park stated for the Charlotte Observer, “We want kids to enjoy learning. The school is not about building young artists, but building young learners. Kids who love school and learn through the arts.”

University Park school and Northwest were actually two of the older schools in the northwest section of Charlotte Mecklenburg, however, the schools closed and reopened after massive renovations in 1996 to be the creative arts schools that they are today. The three arts schools have a rich history in Charlotte-Mecklenburg Schools. First Ward, which transitioned from an accelerated learning magnet to a creative arts magnet much later in the CMS-Magnet School history records, is committed to incorporating Arts Integration and creating a community of 21st
century learners while fostering creativity, imagination, interdependence, independent thought, and life-long learning.

Northwest School of the Arts is the quintessential arts magnet with its students performing on Broadway, alumni attending well established arts schools, and receiving regional and national awards. The secondary arts magnet school offers performing and visual arts and students must prepare for and meet the audition requirements to enroll in the middle and high school. Noted on the school’s website are the words, “our students are trained for the creative jobs they wish to hold post-college, while building vital skills transferrable to other occupations.”

http://schools.cms.k12.nc.us/northwestHS/Pages/AboutOurSchool.aspx

A+ Schools Program

The A+ Schools Program was established in North Carolina in 1995 and now has 130 member schools nationwide. A+ aims to build creative, arts-integrated learning opportunities for all students. This comprehensive education reform is pervasive in schools in that all areas of the curriculum are encompassed, as are scheduling, parent involvement, and extensive professional development. The arts serve as a catalyst for creating connections and making schools engaging.

The eight A+ Essentials are a set of standards that each school in the A+ Network is committed to and they provide a framework for the program. Arts integration, which is essential to creativity and learning, is experienced through education, integration, and exposure, and is part of the whole school’s identity. Curriculum planning is intentional in its efforts to explore and map out strategies for cross-curricular, two-way integration, and vertical alignment, as well as, planning intentional integration to promote student engagement. Howard Gardner’s Multiple Intelligence theory provides a focus on building 21st century skills and the whole child, balancing learning opportunities for all students. Enriched Assessment involves developing experiential,
collaboration, and reflective measures of mastery. Experiential Learning, including creating hands-on engaging activities that encourage innovation, creativity, and critical thinking, is emphasized, as is collaboration, strengthening partnerships among those in the building and in the community. Collaboration is intentional and valued. Infrastructure involves organizing the school structure and schedule to support the program. Also included is the essential element of Climate, building a supportive environment where teachers and students are excited about learning together. Climate also involves sharing and celebrating together, which helps build joy (Retrieved from http://aplus-schools.ncdcr.gov).

The arts serve as the backdrop for this career mentoring pilot study, which is designed to investigate the impact Science, Technology, Engineering, and Math experiential learning activities conducted and processed through the use of STEM mentors can have on students who are motivated toward creativity and innovation. The changes in globalization due to the advances in technology have spawned a great need for workers in the STEM areas, however, technical skills are not sufficient. Soft skills such as team work, critical thinking, problem-solving, creativity and innovation are mandates when solving issues in energy, culture, trade, education, the environment, human rights, and a host of other powerhouse issues facing our world. The research shows a trend of students’ interest waning in the STEM areas after their middle school years, and the interest for women and minorities declining even earlier.

Research shows the importance of early intervention in helping children learn to think and problem solve. Senior Vice President of Boeing, Rick Stephens, was cited in the Southeast Education Network Magazine as saying, “We need to start early, even before kindergarten, to nurture children’s natural curiosity. It’s a first step in creating a skilled workforce that allows the U.S. to compete globally.” According to Sneideman, (2013), an ideal way to get young children
involved in STEM is to go out in nature. He points out that success in learning requires the learner to be at the center of the experience, making connections and looking at the same material in different ways, through different lenses. STEM in nature gives children a chance to investigate and come up with their own questions, identifying patterns, comparing and truly becoming involved in their own learning.

**CFNC Interest Explorer**

The College Foundation of North Carolina Career Interest Explorer was given to the participants to determine their career personality type, based on John Holland’s career theory. It is theorized that most people are one of six personality types and are more likely to be successful and satisfied if in a similar corresponding work environment. The six types are realistic, investigative, artistic, social, enterprising, and conventional. The realistic type personality and work environment are ideally practical and mechanical. Realistic types are good at working with tools, mechanical or electrical drawings, machines, or animals. The investigative personality and work environment value a scientific, precise, intellectual space and enjoy solving science and math problems. The artistic personality enjoys environments that allow them to be expressive, original and independent. Work such as creative writing, dance, music and art are enjoyed by artistic personalities. The social personality types value people and are helpful, friendly, and are good at teaching, counseling, nursing, and solving social problems. Enterprising personality types are often seen in business and legal settings. These people are energetic, ambitious, and sociable. They are good in politics, leading people and selling things. The conventional personality and work environment values jobs in banks and real estate. They are orderly and good at following a set plan. These types are numbers people and prefer working in an orderly, systemic way.
**STEM-CIS**

The STEM Career Interest Survey (STEM-CIS) is used as a pre and post assessment, examining the participants’ level of perceived self-efficacy, which is the belief they have in their capabilities of mastery in these areas. STEM-CIS is a 44-item survey that was based on key aspects of the social cognitive career theory which suggests that the most influential component to goal setting is self-efficacy and that outcome expectations affect interest, when interacting with self-efficacy. The relationship between self-efficacy, outcome expectations and goals to supports and barriers, personal inputs, such as gender, race to interests, explains how individuals make career-related decisions (Kier, et al. 2013).

The STEM-CIS contains four subscales in science, technology, engineering, and math, each with eleven statements such as, I am able to get a good grade in science, and I plan to use mathematics in my future career. Each statement is a Likert scale with the following choices, Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5). These items are linked appropriately to all aspects of the social cognitive career theory. For the purposes of this study each subscale of the pre-test was totaled and compared to those of the post-test for each individual student to determine the percentage of self-efficacy increase, decrease, or no change.

**STEM & Arts Education**

STEM and the ARTS have always had an on-going alliance and it is hypothesized in this study that the participants will indeed realize the strength that their arts backgrounds bring to the 21st century learning environment. Initially it was thought that incorporating the arts into the STEM conversation would distract from the focus of the hard sciences, however, the addition of the arts in attracting young people to the STEM areas is more about sparking student’s
imagination and creativity, applying the skills of design and innovation to STEM projects, and keeping young people engaged (Feldman, 2015). There are ten skills, according to Phillips, (2012), that children learn from the arts, creativity, confidence, problem-solving, perseverance, focus, non-verbal communication, receiving constructive feedback, collaboration, dedication, and accountability. Through the arts students are constantly challenged to approach tasks from different perspectives and to think outside the box. Children must step out of their comfort zone and make mistakes and learn from them in rehearsals, and then be able to command the stage in performance. The arts are a wonderful vehicle in developing the concentration and mental focus to remember lines and keep a balance between listening and contributing. Teamwork and being a part of an ensemble are most powerful in helping children learn to work together and share responsibility, while receiving feedback for greater improvement of skills. These skills are fundamental in the arts and most beneficial in the science, technology, engineering, and math fields, as well as in life. The state-wide advocacy group, “Arts North Carolina” brandishes these sentiments in their vision statement:

Vision for Arts Education

In today’s globally competitive world, innovative thinking and creativity are essential for all school children. High quality standards-based instruction in the arts develops these skills and effectively engages, retains, and prepares future-ready students for graduation and success in an entrepreneurial economy. Dance, music, theatre arts, and visual arts, taught by licensed arts educators and integrated throughout the curriculum, are critical to North Carolina’s 21st century education.

Career Mentoring

In this study volunteer career mentors use hands-on highly engaging activities to work with the participants. Career Mentoring is a way to connect skilled professionals with students, who benefit from the knowledge and experiential exercises that the career mentors develop and share with them. These volunteers help students understand what it takes to become successful and share their life experiences in a unique way. Career Mentors develop a relationship with a student or group of students, encouraging, motivating, and exposing them to careers and the world of work. This kind of exchange can help students experience potential careers from the inside. Career Mentoring is valuable in an age when there are so many career options and possible opportunities for young people. Many children don’t have parents or other family members who can provide the kind of insight into careers, especially in the areas of Science, Technology, Engineering, and Math. Career Mentors can be helpful to students in a number of ways:

Helping improve their mentee’s academic skills.

Mentors can help improve their mentee’s self-esteem.

Mentors can teach their mentees how to relate to all kinds of people and help strengthen communication skills.

Mentors can help young people set career goals and start taking steps to realize those goals.

Mentors can use their personal contacts to help their mentee meet industry professionals find internships and locate possible jobs and other professional exposure.

Statistics show that student mentees are 52% less likely than their peers to skip a day of school.
46% less likely than their peers to use illegal drugs and 27% less likely to start drinking (http://www.mentoring.org/about_mentor/value_of_mentoring/).

**College and Career Readiness**

The White House has called for all states to develop standards in Math and English that build toward college readiness by the time every child finishes high school. Due to the demands and complexities of the 21st century workforce it is imperative that students graduate ready for the challenges ahead. College and Career Readiness means that a student graduating from high school has knowledge and skills to successfully enter the workforce in an entry-level position or enter post-secondary education without the need for remediation. The Obama Administration set the goal for 2020, that all students will graduate or be on-track to graduate college and career ready. There are eight components to the systemic comprehensive plan to achieve this goal, college aspirations, academic planning for college and career readiness, enrichment and extra-curricular engagement, college and career exploration and selection, college and career assessments, college affordability planning, college and career admission, and transition from high school to college.

The College Board’s National Office for School Counselor Advocacy (NOSCA) has also charged school counselors with the task of advancing school reform and student achievement in the area of college and career readiness (“Resources for School Counselors,” n.d.). The goals for college and career readiness starts in kindergarten through twelve grade. Elementary school counselors and teachers are charged with creating early awareness and skills that will lay the foundation for academic rigor and social development necessary for college and career readiness.
Self-efficacy, which leads to self-confidence, will play a role in how ready students feel they are to tackle the challenges.

**Creativity and Innovation**

Creativity and Innovation skills are recognized as those necessary for students who are preparing to be successful in the 21st century. Creativity is defined as the use of imagination and original ideas to create something new, the process of developing new, uncommon, unique ideas, and characterized by originality and expressiveness. Sir Ken Robinson states that, “Creativity is important now in education as literacy and we should treat it with the same status.” Ainissa Ramirez, who calls herself a Science Evangelist, states that creativity is really the art of metaphor. Metaphors create linkage between the unknown and the known. We must create scholars who are willing to try many combinations before finding the right answer, and must be comfortable finding new ways of thinking (Ramirez, 2013).

All students can develop their creative capacities in environments that nurture and support creative development. The creative process involves seeing something in the mind’s eye, using imagination to solve problems, and then innovation, which is putting that creativity into practice. Innovation is viewed as the process of implementing new ideas to create value. It may be a service, system, process, or enhancing an existing one. Innovation is crucial for economic growth and our country’s competitiveness consequently necessary as one of those 21st century skills we must help inspire in our students. Creativity can be thought of as the process of thinking up new things and concepts, while innovation is the process of converting those thoughts into tangible things. Creativity and innovation are key drivers in the global economy. It is important that we nurture creative thinking in our education system. The ability to create something new and better
is a skill that organizations worldwide are looking for today. They want to know what you can do with what you know.

**Statement of the Problem**

“If we want America to lead in the 21st century, nothing is more important than giving everyone the best education possible — from the day they start preschool to the day they start their career.”

"... Leadership tomorrow depends on how we educate our students today—especially in science, technology, engineering and math."

—President Barack Obama

The United States government, economists, business forecasters, and educators all tell us that eight out of ten jobs in the coming decades will require a background in science, technology, engineering, and math (STEM). Those career fields will be growing twice as fast as non-STEM fields. Identifying what is over-arching and over-lapping about science and the fields of technology, engineering, and math is how the acronym STEM was born (http://www.ed.gov/stem). Expertise in the STEM fields promotes inventiveness, scientific discovery, and efficiency in the ways things are done. STEM education and enrichment are national priorities and our low ranking in science and math among several Asian and European countries has set off the alarms (Generation STEM). Students need more in-depth knowledge of math and science, plus the ability to integrate and apply that knowledge to solve the challenges facing our nation and our world. Children who study STEM also develop a variety of skills that are essential for success: critical thinking and problem solving, creativity and innovation, communication, collaboration, and entrepreneurship (Jolly, 2014).

However, concerns about our nation’s economic competitiveness are real. Too many students are graduating from high school unprepared with the needed skills in math and science to be
successful in college STEM courses (Flammer, 2013). Poor academic performance and declining interest in STEM-based careers is a looming problem in the U.S. Students lack of motivation in the STEM areas has resulted in the U. S. relying on a foreign-born workforce.

While there are a number of factors that contribute to students’ lack of enthusiasm in STEM, according to Ketelhut, 2007) the perception that science is hard and for the “smart” elite kids is one that needs to be eradicated. Those students with confidence in their capabilities continue to participate in the experimentation and activity but when they lost confidence, would not fully participate which would result in failure. Helping to improve student’s self-efficacy seems to be a good place to start in stopping this cycle of failure. In this study self-efficacy was measured prior to the mentoring program and after the intervention of hands-on STEM activities was given. We know that success improves self-efficacy, so positive experiences in STEM in early years we hope will contribute to a positive self – perception in the future. Educators can best build students’ STEM self-efficacy by providing them with STEM opportunities, experiences, and role models and by encouraging them to pursue STEM interests and persist despite difficulties.

Success in STEM is important for academic and economic reasons. The United States is under pressure to maintain its global competitiveness. The mission for all students’ education is to learn how to communicate, how to think, and how to relate. Math, science and also the arts play a major part in critical thinking. They give us the ability to interpret, evaluate, solve, and verify. The inadequate development of math and science understanding at a pre-college level means a significant underdevelopment of an individuals’ intellectual potential (Hatch, 2014). There has been a downward slide in the STEM fields in the United States, which has been examined extensively. Improvements in the curriculum, the need for a strong foundation in
sciences knowledge prior to high school, and lack of teacher training in math and science have been cited as areas needing improvement (Hatch, 2014). There are also cultural factors that help attribute to the lack of awareness of the opportunities for careers in the STEM fields, and contribute to the gender gaps, and socio-economic and ethnic disparities.

The lack of interested students in the Science, Technology, Engineering, and Math areas in education is a much talked about concern, however even with additional federal funding to recruit especially underrepresented groups such as women and minorities, there has not been a significant increase in interested students. Research points to a continued underrepresentation of women in STEM careers despite their high academic achievements and success in other career fields. Today 57% of the college graduates and 60% of master’s level graduates are women, however only 20% of the bachelor’s degrees in engineering, computer science, and physics are held by women. A number of factors are known to influence young women’s perceptions of their abilities in math and science. Outdated stereotypes and feelings of insufficiency often hold girls back (Generation STEM).

A Generation STEM, Girl Scout study found that girls do indeed have an interest in STEM, they like to understand how things work, solve problems, do creative hands-on activities, and ask questions. Girls who are most interested in STEM, they found, are high achievers, better students, have stronger support systems, and have been exposed to STEM fields. Researchers and experts in STEM education agree that expanding the number of women in STEM fields would bring a new dimension to the work and potentially tackle problems that have been overlooked in the past.
STEAM

There is a movement in this country advocating for the integration of the arts into STEM. It is argued that interdisciplinary work in arts and sciences can lead to a combination of aesthetic and analytical thinking to the betterment of both science and art (Bequette, 2012). According to (Taylor, 2011), students must be taught to function in a globalized 21st century, acquiring “habits of mind” that enable them to develop the skills of creativity, critical thinking, communicate effectively, problem-solving, and collaborating with people different from themselves, which are in reality arts skills. These skills, which are routinely employed by artists and arts educators, can be used interdisciplinary, however arts education has promoted practitioner development above all else, relegating those arts-inspired skills to acting, dancing, musicianship and visual art.

Cultivating creativity and innovation is the center of conversation among those in industry. These essential qualities nurtured by an art and design education is what the U.S. urgently needs to foster economic growth and competitiveness. Pairing the analytical nature of STEM with the creative potential of the arts will enable our students to push boundaries and challenge the status quo. When combined with STEM, the skills learned through the arts allow for true innovation. In 2013 a bipartisan Congressional caucus was held in Washington, DC to discuss and implement STEAM education (Michaud, 2014). STEAM initiatives are springing up all over the country in the public schools and higher education realm.

We can ignite the desire, appreciation, and love of STEM through the arts because the arts are about active learning. Through dramatic play students learn problem-solving skills and develop creativity. As Kouyate, senior director of education at Wolf Trap Institute for Early Learning explains, children who become interested in STEM early through the arts and active play, grow up to be inventive adults who contribute to the 21st century global economy (Philpot, 2013).
Significance of the Problem

Businesses in every country are competing in an increasingly global market-place. The workforce of the 21st century must be able to compete and collaborate in a world of constant innovation pushed by accelerating new technologies. Creative talents are needed to generate the innovative solutions demanded by the market-place. Determining the skills and abilities that cultivate creativity is paramount in nurturing the workforce of the future. Employers are increasingly placing strategic value on the importance of employing creative workers. Businesses and educators must join forces in sculpting the kind of talent teams who bring thinking with both the logical – analytical and creative sides of their brains (Lichtenberg, Woock, Wright, 2008).

In this conceptual age, according to Daniel Pink, the right-brainers will rule the future. In his premise those with metaphorical, aesthetic, and contextual sensibilities will have an advantage over those left-brainers, with the analytical, technical, sensibilities (Pink, 2006). Business leaders increasingly acknowledge critical thinking, creativity, and innovation as among the top applied skills necessary for workers in all industries. Pink suggests that there are basic skills in this conceptual age. He calls them the six senses, design, symphony, empathy, play, and meaning. Together, he suggests these high concept, high touch senses can help develop a whole new mind. There’s nothing new about these concepts however the U. S. has moved more toward the linear model of thinking and educating. There is no doubt that we need a balance in this 21st century world.

In a time when education is most important, it is reported that the United States is failing to adequately prepare students, and those in industry are wondering where their future workforce will be coming from. To prepare students for our changing world, schools from elementary to
high school are preparing students for college, careers, and citizenship. Students not only must be academically prepared but must be problem-solvers, and possess the 4C’s competencies, collaboration, creativity, communication, and critical thinking (Edutopia.org A Parent’s Guide to 21st century learning).

It is projected that the US will face a shortage of college graduates in science, technology, engineering, and math (STEM) related areas, and that about 50% of all graduates are non-US citizens and ineligible for security clearance. National statistics in U.S. math and science education in K-12 indicate that 40% of all students test below basic math level, which include 70% of both African-American and Latino students. 50% of all students and 70-80% of African-American and Latino students test below basic science. STEM education has become a workforce issue as our country is challenged by high unemployment and companies looking for skilled workers.

The over-arching goal is for students to have 21st century skills, which include the ability to think through problems, evaluate the problem, work through it and ask intelligent questions. Businesses are seeking team players and collaborators because many of the jobs require group work, which may be local or global. Workers who are competent academically as well as creative and innovative will set the standards. We often compare ourselves to countries like India and China, who have exponentially more populous, which means that even if they educate a fraction of their population to be excellent mathematicians and scientists, those sheer numbers would match the entire population of the United States. What we have though is a free society with the capability of cultivating creative minds with free flowing imaginations. The combination of technical and imaginative is how we can compete.
**Research Questions and Goals**

The goal of this research was to develop a pilot for a Career Mentoring Program that can help girls in elementary school who have an affinity for the arts, recognize the strengths and career skills they can bring to a 21st Century world that seems to value Science, Technology, Engineering, and Math (STEM). Oftentimes students do not realize the role the arts play in those disciplines. This program will help the arts – inspired students realize that the skills that they acquire and naturally possess are absolutely needed and valued in the STEM areas. Students participated in activities crafted to enhance creative thinking and problem-solving skills. The hypothesis is that through this blended learning, creative arts students will be inspired and can be taught to recognize that they have assets which can help prepare them for careers in STEM as well as Arts-related fields. The following research questions drive this pilot study:

**Research Questions**

1. Do arts-inspired students have an interest in a STEM career area prior to participating in the career mentoring program?
2. Does participation in a STEM career mentoring program improve student’s self-efficacy in STEM fields?
3. Does participation in STEM career mentoring program increase student’s interest in pursuing STEM-related careers?

**Theoretical Framework**

The purpose of this study was to explore the ways in which students’ career interests in STEM develop and self-efficacy increase in response to career mentoring. The Social Cognitive Career Theory provides the framework used in this research. Social Scientist Albert Bandura’s Social Cognitive theory served as the backdrop for the Social Cognitive Career Theory. It is theorized that the three building blocks of career development are self-efficacy, outcome
expectations, and personal goals. Self-efficacy is the belief that one has about their abilities to succeed in a specific task. Outcome expectations are the beliefs about the outcome of performing a particular behavior, and Personal goals is one’s determination to partake in a particular activity (Lent, Brown, & Hackett, 1994).

Self-efficacy beliefs are strengthened when personal accomplishments in a given task are realized, through observation and experiencing vicariously, and the positive physiological states experienced surrounding this activity. According to Social Cognitive Career theory, a person’s engagement in activities, and the effort and persistence they put into them, and their ultimate success are partly determined by their self-efficacy and outcome expectations. One’s personal goals help to organize and guide their own behavior. People tend to set goals consistent with their beliefs about their ability to be successful, which becomes important in helping confirm their self-efficacy and outcome expectations.

Table:1.1

Social Cognitive Career Theory
Perceived barriers are likely to hinder an individual from pursuit of a career choice. Helping to modify faulty self-efficacy and outcome expectations can help individuals acquire successful experiences and become more open to new career occupations. To the contrary, when individuals develop an expertise or skill and meet with success in that area, the belief that future success in that area can be achieved is heightened.

The STEM Self-Efficacy Survey (STEM-CIS) which was used as a pre-test and post-test for this project was developed using the Social Cognitive Career Theory. This instrument was created with the impetus to measure STEM career interests and the effects of STEM programs on changes in student interests in STEM subjects and careers. There had not been an instrument using the social cognitive aspects to develop a survey measuring interest and intent to pursue academic choices or careers in STEM for middle school students. Therefore, given the utility of this theoretical framework, a survey measuring interest in each subject area with aspects derived from the Social Cognitive Career Theory was crafted (Kier, Blanchard, Osborne, & Albert, 2014).

Daniel Pink’s book, *A Whole New Mind: Why Right-Brainers Will Rule the Future* has also influenced this research and paved the way for the prominence and center stage of the arts. In his book, Daniel Pink introduces the six senses, Design, Story, Symphony, Empathy, Play, and Meaning as being essential elements that will guide our lives and shape our world in this 21st century. For decades those with more conventional, logical, sequential, linear thinking have moved our world forward. According to Daniel Pink, we have embarked on a new age, the conceptual age, which requires in addition to left-brained capabilities, the right-brained qualities of inventiveness, empathy, joyfulness, intuitive, and non-linear reasoning (Pink, D., 2006).
The six senses or aptitudes must be mastered for personal and professional success. These qualities were applied to the various lessons and helped shape the participants’ experiences in this study.

Creating with aesthetics in mind is critical. Crafting the story of our experiences will be more compelling than an effective argument. Synthesis or symphony is needed in seeing the big picture and all those related parts to build a new whole. The ability to step into someone else’s shoes, being empathetic, will distinguish those who succeed in this new era. Play is also a critical element because all work will surely make us all very, very dull, and lastly meaning and purpose, which is being pursued in record numbers in our world.

The Whole New Mind concepts, along with implications from the Social Cognitive Career theory, have informed my inquiry in a number of ways. First in realizing the significance of the arts in the STEAM Movement. Secondly, understanding some of the reasons for the lack of significant female representation in the STEM areas, which I intend to investigate in the pilot study. Lastly, grasping the importance of observation and positive experiences through the help of career mentors in helping to improve self-efficacy in the STEM areas.

**Research Design**

The research questions of this study and the research instrument both yield to a quantitative approach. The pre and post-survey with a 5-point Likert scale design allowed for quantitative results even when asking qualitative questions. The STEM Career Interest Survey was designed to be used as a pre and post survey, evaluating the effectiveness of STEM related interventions. The STEM Career Interest Survey was developed by Kier, Blanchard, Osborne, and Albert. The Social Cognitive Career Theory was used in developing this instrument with subsets in Science, Technology, Engineering, and Math. Questions relating to the participants’ self-efficacy are used
to assess the effectiveness of the interventions, which in this case involve career mentors with hands-on, highly experiential activities that simulate the conditions conducive to the occupations.

The STEM Career Interest Survey developed in this study was shown to be psychometrically sound and able to be used by researchers or professional developers in science, technology, engineering, and mathematics, using one or more subscales or all of them as one instrument, as needed. As such, the authors expect it will be beneficial to researchers, professional developers, and evaluators in measuring STEM career interest and the effects of STEM programs on changes in student interest in STEM subjects and careers (Kier, Blanchard, Osborne, & Albert, 2013). Permission was obtained from the authors of this instrument that it be used for this project.

Students were also given the College Foundation of North Carolina (CFNC) Career Interest Explorer, which was adapted from John Holland’s career theory. Holland’s theory of career choice has broken down work environments and personality types into six categories, realistic, enterprising, social, conventional, artistic, and investigative. The theory states that persons who work in environments that match their personalities are more likely to be successful and satisfied in their lives. The test consisted of 30 example tasks that the participants choose and they are then able to find the career category that they fit. This is the first step, and an important step in the career development process, finding more about who you are, what your interests are, and how you feel most comfortable and would feel most comfortable in a work environment. This survey was used in this study to determine which participants scored highest in the area of Artistic personality as opposed to Enterprising, Social, Realistic, Conventional, and Investigative.
Limitations of the Study

This pilot study contributes a quantitative insight into the feelings and self-efficacy of students who are inspired by the arts and their career expectations, however, there are limitations to this study. The instrument used, the STEM Career Interest Survey, delivered as promised, however including a qualitative perspective may have enhanced this project by bringing further understanding to the feelings of the participants. Encouraging reflection and capturing feelings by giving the participants a voice would enrich this project and give a greater depth and meaning. It is recommended that when expanding this study an exploration of student voice be implemented. The roundtable discussions in this pilot study were not recorded, however, in the larger study, participants may even keep a journal to document their feelings and growth during this process.

The participant selection for this study was a convenience sample of participants, in which respondents were chosen based on their convenience and availability, which limits the ability to generalize to a population. The sample size and recruits were based on the participants enrolled in the “I AM Complete” program. A larger study can employ different methods of sampling due to the much larger population.

Positionality Statement

“Find Your PASSION…Make It A Job!” was my tag line just a few years ago while working as a Middle School Career Facilitator for Charlotte-Mecklenburg Schools. There were 10 of us in the system and we each had approximately 3 middle schools that we serviced. I worked with the 8th grade students at each of my assigned schools, conducting self-assessments, providing career exploration experiences, as well as, helping students set goals and plan how they would achieve
those goals. We designed a comprehensive career program for the schools and collaborated with community partners to bring a variety of career experiences to the students.

This dissertation project is a reflection of this researcher’s values and passion in helping students find meaning, purpose, and direction in their lives. As a school counselor, I work with students on their social/emotional, academic, and career needs, however I do believe in order to feel whole, and successful in life we must align ourselves with our purpose.

I also have shared experiences with the participants in this pilot study. As a high school student I studied opera vocal performance which lead to a scholarship to college. Understanding the highs and lows of an artistic career and encouraging arts-inspired students to open themselves up to other possibilities in the world of work, was one of the aspects of this research that made sense.

Though this study implored a quantitative method with precise, numerical data, which is relatively independent of the researcher, as (Throne, n.d.), states transparency in the perspectives brought to a work of this kind help define a clear viewpoint in the conclusions and implications from its results. This self-disclosure will also highlight expectations of the researcher and the need to self-check my biases at the door.

**Chapter Two: Literature Review**

**STEM**

In our 21st century reality our country is buzzing with expectancy and reluctance around the education and preparation of our future leaders and workforce. At a time when the global village is realized due to our fast changing technology, communications, and infrastructure, the United States is falling in the ranks of educating our students in the areas of STEM (science, technology,
engineering, and math). The health and longevity of the United States is dependent upon our ability to improve healthcare, protect the environment, make better and smarter products, inspire new industries and safeguard us from harm. STEM related occupations are expected to increase over 16% from 2008 to 2018. Yet only 16 percent of American high school seniors are proficient in math and interested in a STEM career. Even among those who do go on to pursue a college major in the STEM fields, only about half choose to work in a related career. The United States is falling behind internationally, ranking 29th in math and 22nd in science among industrialized nations. In many urban areas the graduation rate is about 50% and about 40% need remediation once they get to college. Women and other minority groups are underrepresented in the STEM areas. U.S. businesses are having a hard time finding workers that have the STEM skills needed. Technical skills are needed as well as those soft skills such as creativity, imagination, problem-solving, critical thinking, and innovation.

This is a review of the literature surrounding this problem and highlights ways in which businesses, educational systems, and the U. S. government are working to alleviate this crisis. Reforming education in the United States is viewed as the way in which young people will develop the technical and soft skills needed to become competitive in this new economy.

Tyson, (2009) remembers that at the onset of the middle school movement, emphasis was placed on extending critical thinking, problem-solving, project-based learning activities, and providing relevant curriculum through engaging practice geared to the nature of adolescent youth. Many of these values are characterized today as 21st century learning. Tyson suggests that due to high stakes testing and accountability efforts, educators have slowly gotten away from this “substance of soul.”
Through technology, Tyson says, educators have an opportunity to empower students to use their classwork to make the world a better place. Technology must become a routine way to conduct investigations and create student learning projects that make a difference, and that by the use of technology, will be shared around the world. Middle schools would then take on a higher purpose, while engaging students in the critical 21st century skills. In order to rediscover the substance of soul for middle school students, curriculum must be made relevant, challenging, integrative, exploratory, and meaningful.

Windsor, A., et.al (2015) conducted a study of the MemphiStep program at the University of Memphis, sponsored by the National Science Foundation that focused on retention and persistence to graduation to increase the number of STEM majors and graduates. The program proposed to increase the number of STEM graduates from 212 in 2005 to 335 by 2013 which represents a 60% increase, by instituting a number of student retention activities. By the summer of 2013 research data indicated an increase to 320 student STEM graduates. This study was designed to analyze the impact of the MemphiStep program on persistence to graduate and program effectiveness.

Five different programs were used to help MemphiStep reach its goal, a Summer Mathematics Bridge Bootcamp to help boost math skills and give students an opportunity to network and discover STEM career options, Networking Program that gave students a chance to attend large group events like mixers and field trips with upper-level STEM students and faculty, an Undergraduate Research Program the gave the students an opportunity to participate in paid STEM research, a travel Award Program which offered funding to students to attend conferences and other STEM related activities, and Learning Communities which have students taking common classes, similar to cohorts.
In investigating the effectiveness of the program the performance measures were overall GPA and retention in a STEM major. The statistical analysis data indicates that the MemphiStep program is having a positive impact on student performance and retention for STEM students at the University of Memphis. All five individual programs were found to have a positive impact on student retention. The programs are set to be continued and the hope is that other institutions will be able to replicate some of the programs to retain STEM students as well.

Governmental Priorities

President Obama has made STEM education a top priority with a goal of moving American students to the top in science and math within this decade. The Administration is also working toward an equitable distribution of quality STEM learning opportunities, including a talented teaching staff for all students. The Committee on STEM Education has developed a nation-wide plan to increase federal funding in the 5 areas: 1) improving STEM instruction in pre-school through 12th grade; 2) increasing and sustaining public and youth engagement with STEM; 3.) improving the STEM experience for undergraduate students; 4.) better serving groups historically underrepresented in STEM fields; and 5.) designing graduate education for tomorrow’s STEM workforce (http://www.ed.gov/stem).

Hilton (2008), provides a look at the research presented at the National research Council’s Research on Future Skill Demands workshop. It is widely recognized and studied that the United States educational system is not producing an internationally competitive workforce. The gap in skill requirements and wages between the high skill/higher wage jobs and the lower skill/lower wage jobs is broadening. The future polarization of the labor market suggests major societal issues to come.
Computerization and outsourcing of work to other countries has contributed to this imbalance in the labor force. In higher wage/higher skill jobs which are referred to as knowledge work, three trends affect this work, globalization of scientific and engineering work, the complexity of skills required, and the role of the bioscience industry to help create jobs. Information Technology makes up a large part of the scientific and engineering workforce. It is projected that 40% of IT and 60-70% of engineering could be outsourced. China and India are our major competitors.

The service industry is growing rapidly. Though these jobs are known to be low skill/low wage, there is a growing importance of social and esthetic skills for service work in retail sales, hotels, bars, and cafes.

There are no doubt competing views on the subject, but some of the concluding thoughts are:

1. Some demand in the high skill/high wage sector may be off-set by outsourcing. Many of those jobs will be sent to other countries.
2. Career & Technical Education is promising for young people to gain broad competencies.
3. The wealthy U.S. can afford to provide better jobs and higher wages.
4. Approaches that link education and careers should be studied.

Robotics competitions have shown to be a wonderfully exciting and engaging way to interest students in the areas of science, technology, engineering and math. Robofest, which started in 2000 to teach STEM skills to pre-college students, is now an international competition and has served over 12,000 students in thirteen U.S. states and eight countries.

The White House Council on Women and Girls is dedicated to increasing the participation of women and girls — as well as other underrepresented groups — in the fields of science, technology, engineering, and mathematics by increasing the engagement of girls with STEM
subjects in formal and informal environments, encouraging mentoring to support women throughout their academic and professional experiences, and supporting efforts to retain women in the STEM workforce. Today half of those working are female and young women are more likely to graduate from college than young men. Despite these gains, women still make only 77 cents to each dollar that a man makes. The Obama Administration has sought to encourage and inspire girls to get into the higher paying careers such as those in the STEM fields through grants, mentorship programs, partnerships and legislation that reduce the barriers and opportunities to attract and retain women in these fields (White House website 2014 Obama Administration record on women and girls).

STEMConnector launched the Million Women Mentors program in 2014 and were successful in matching one million STEM professionals with girls aspiring to pursue STEM degrees. Most experts agree that it is advantageous to engage girls in STEM early. Studies show that girls lose interest in math and science during the middle school grades so the Girl Scouts of America has taken on the challenge by trying to hear what girls have to say.

Generation STEM (2012), a study conducted by the Girl Scouts of America, explored ways in which girls can become more engaged in STEM by listening to what the girls say their interests and perceptions are about the STEM fields. 140 girls from around the country participated in focus groups, which contributed to the qualitative findings in the study, and 852 girls were fielded in an online survey, which contributed to the quantitative findings. The study found that girls are interested in the process of learning, asking questions, and problem-solving. Girls who are interested in STEM are generally high-achievers. African-American and Hispanic girls have high interest in STEM and high confidence but fewer supports, less exposure, and less academic achievement.
There are a number of factors that negatively influence the perception of girls and the STEM fields. The stereotype that girls are not as good as boys in math and science can still be internalized and girls may feel inadequate. Parents may unconsciously encourage their boys in areas of math and science but discourage their girls. Nevertheless, the girls in this study had high aspirations for their futures and were confident in their abilities. These internal assets may be just what is needed to keep girls interested in the STEM fields as they get older. Other recommendations were to encourage young girls to ask questions about the world, to use natural creativity through play and experimentation, expose girls to people who have careers in STEM and let them hear their stories, provide students with career counseling and opportunities to get college and career ready.

The STEM Education Coalition is a non-profit group that advocates for STEM education, and its central mission is to inform the state and national policy makers of the importance that STEM education plays in the competitiveness and economic prosperity of our country. According to the Coalition, there is no universally agreed-upon definition of STEM. Experts generally do agree, however, that STEM workers use their knowledge of science, technology, engineering, or math to try to understand how the world works and to solve problems. Their work often involves the use of computers and other tools. STEM occupations are closely related and build upon one another. Science workers study the physical and natural world through observation and experimentation. The work of scientists often involves research, writing proposals and academic papers, and presenting findings. Science technicians collect samples, conduct experiments, and do other tasks to assist scientists in those efforts. Workers rely on the scientific method to objectively test hypotheses and theories. The scientific method requires repeatable experiments that produce predictable and observable data. When the data matches a theory’s predictions, the
experiment supports that theory. Theories with the most supportive evidence are adopted but may continue to evolve, based on new evidence.

Technology workers use science and engineering to create and troubleshoot computer and information systems. Technology connects people, making business transactions and all kinds of communication and problem solving easier. Engineers use math, science, and technology to solve real-world problems. The work often involves developing systems, structures, products, or materials. Engineering makes things better and cheaper. Mathematicians use numerical, spatial, and logical relationships to study and solve problems. Mathematics is the technical foundation for science, engineering, and technology. The work often involves finding patterns in data or abstract logic. These patterns can be used to draw general conclusions about data, to test mathematical relationships, and to model the real world (STEM Education Coalition website http://www.stemedcoalition.org/).

In addition to a technical foundation, STEM workers must have strong thinking and communication skills and thinking skills. Critical and creative thinking help STEM workers in problem solving to detect mistakes, gather relevant information, and understand how different parts or systems interact with each other. STEM workers also need thinking skills to develop innovative, cost-effective solutions. The National Education Association (NEA) has lead the way in the 21st Century Skills movement. They helped establish the Partnership for 21st Century Skills, which along with business leaders and educators developed a “Framework for 21st Century Learning.”

The “Framework for 21st Century Learning” initially highlighted 18 different skills that would be needed in moving 21st century learning forward. Since then, all agreed that there were actually 4 specific skills that were the most important. They are the 4 C’s, critical thinking,
communication, collaboration, and creativity. These skills are to be incorporated in the curriculum and in every classroom (NEA Preparing 21st Century Students for a Global Society).

Critical thinking is using different types of reasoning as appropriate to a given situation. Critical thinking is effectively analyzing and evaluating evidence, arguments, claims, and beliefs. When a person is thinking critically they ask clarifying questions, interpret information and draw conclusions based on the best analysis. The importance of teaching critical thinking and students learning to think critically is vital. Students then learn other skills such as higher concentration, deeper analytical abilities and improved thought processing. To solve problems facing our world, we must have those critical thinking and problem-solving skills.

Communication is the process of articulating thoughts and ideas effectively using oral, written, and non-verbal communication skills. Those who communicate effectively are good listeners to what is being said and able to decipher meaning, including knowledge, values, attitudes, and intentions. We live in a world with an enormous amount of information available. Students must be able to analyze and process to determine which information sources are accurate, and how to best use the information given. Explaining, negotiating, presenting are all forms of communication that will be essential in the 21st century workplace.

Collaboration is the ability to work effectively with others, which is essential in this global environment. Exercising flexibility and a willingness to be helpful and compromising are key in a collaborative atmosphere. Those who are collaborating assume a shared responsibility for the task at hand. The diversity of the individual members make for a much more substantial outcome or product.

Creativity in the 21st century requires that we transcend traditional ideas and methods for meaningful, original, progressive, imaginative and insightful new ideas. To cultivate a creative
mind in education, it must feature exploration, challenging problems, tolerance and encouragement of productive mistakes. Creativity is seen as the primary mover of our economy and the four C’s, are skills that every child will need to become an effective, contributing working member in this new economy.

Graduating our students, college and career ready is the standard in every school system in the country. To be college and career ready means that students have studied a rigorous curriculum and have the English and math knowledge and skills needed to continue in a post-secondary education program. The foundation of which begins in elementary school and continues through middle and high school with career and technical education and college pathways. Achieve, Inc. ([http://www.achieve.org/about-us](http://www.achieve.org/about-us)) is a non-profit reform organization that is leading the way to making college and career readiness a priority across the country. Achieve has the ability to work with leaders in states, legislatures and state boards of education to help write policy as well as provide technical assistance to states on the design, development, adoption, implementation, and communications of their college- and career-ready standards, assessments, curriculum, and accountability systems. Achieve is actively involved in research and development to advance education reform and to provide the tools necessary in this quest for college and career readiness.

According to the Harvard Graduate School of Education report, “Pathways to Prosperity” there are troubling signs that the U.S. is failing to meet its obligation to prepare millions of young adults. Education has never been more important to the economic success of our country and we are falling behind many other countries in academic attainment and achievement. In the midst of education reform, we must graduate students with the skills that result in a good job ([Symonds, et al., 2011](http://www.achieve.org/about-us)). The Pathways to Prosperity report goes on to chronicle the workforce
demand changes and the impact on education in the U.S. In 1973 when manufacturing was
dominant, people with a high school education or less made up 72 percent of the nation’s
workforce. By 2007 jobs had grown exponentially however the need for post-secondary
education in those positions also grew at the same rate. The trends and long-term projections for
this 21st century economy are clear, the demand for post-secondary education will be paramount.

President Obama has mandated STEM education as a priority for all students in this country.
The Administration is also working toward an equitable distribution of quality STEM
opportunities and teachers to ensure that all children have a chance to reach their potential. This
can only be realized if students of color, women, people with disabilities, and first generation
Americans are supported in these areas. It is essential that our students obtain strong STEM skills
and remain competitive in this global marketplace. Indications suggest (“Federal STEM
Education 5-year plan,” 2013), that students who report an early interest in a STEM career are
much more likely to complete a college degree in a STEM field that students without those
expectations. It is suggested that early exposure to these topics in elementary and middle school
may be important for a student’s future career aspirations.

In surveys by the National Center for Education Statistics, students in early elementary grades
start out with positive attitudes toward science and math. They like to fix things and solve
problems but by eighth grade the same children’s enthusiasm has waned and the confidence in
what roles they can play has diminished. Approximately 22 percent of k-12 students are Hispanic
and over 16 percent are African-American, and half of those students are girls. There are few
role-models in science and math that fit those demographics. At Sally Ride Science Academy
(https://sallyridescience.com/programs) founded by the first woman in space, upper elementary
and middle school students and educators are experiencing science and space camps, festivals,
and professional development on-site and online. Teachers in all disciplines are taught how to cultivate enthusiasm for science and technology online and in person and students are connecting to diverse role-models in STEM professions who are doing fun, amazing things. Sally Ride Academy has a Junior Academy that offers STEAM workshops for girls in the summer months. There are workshops in Ocean Robotics, Virtual Reality Programming, The Music of Earthquakes, and teacher and role-models who offer their life experiences.

Education reformers must look at amending the out-of-date STEM teaching methods and instead look to an interactive, real-world, mentor-based approach that models 21st century critical and creative thinking and energizes appreciation for STEM. For our nation to flourish in this new world economy we must nurture an interest and mastery in STEM in every school (Coan, 2012).

Specific to the research questions, are mentoring programs finding success in building students’ interest and positive feelings toward these STEM fields. There are a number of organizations throughout the country that seek to help students achieve Hands-on STEM mastery. The JASON Project (http://www.jasonproject.org/), is a non-profit organization that connects kids with top scientists and science exploration. Webcasts provide live explorations and events with role-models that is aligned with the national curriculum standards. Jason’s also provides hands-on professional development for teachers complete with lesson plans and assessments. JASON projects reach out to kids in school and out-of-school settings, such as Boys & Girls Club and the YMCA.

The National Science Foundation (NSF) has invested in STEM research and education for over 60 years. Education & Human Resources (EHR), which is one of the NSF’s funding arms’ objective is to develop knowledge and evidence for what really works in STEM education. The strategic areas of focus are understanding how and under what conditions people learn STEM
most effectively preparing underrepresented groups in STEM, training STEM teachers and administrators, and providing engaging opportunities to learn STEM in the community and virtually. Some of the virtual projects include, “Cyberchase”, which is an Emmy Award winning animated series on PBS KIDS GO!. Three kids use math and problem-solving to stop the Hacker. “Zooniverse” which houses over 275,000 users collected data on research questions from solar storm formation to tracking tropical cyclones, and “SciGirls” which follows middle school girls, each episode, who put science to work in their everyday lives. They eagerly explore the world around them as they discover that science and technology are everywhere (National Science Foundation, Education & Human Resources, 2013).

The National Geographic is committed to advancing geo-literacy in the United States and around the world. Understanding how the world works and how people and places are connected is the primary aim. Geo-literacy, according to National Geographic is a natural fit with STEM education. Making decisions require an understanding of how Earth’s human and environmental systems function. Through educational materials and outreach, National Geographic Education not only improves the resources available in STEM classrooms and other learning environments, but also encourages and inspires students of all backgrounds to study in and pursue careers in STEM fields (National Geographic Website).

STEM to STEAM

One of the most empathic, beautifully written works that I have read about transforming education was by educator, Dr. Stephanie Pace Marshall. Her book, *The Power to Transform*, made me feel weepy and empowered, all at once. She spoke about education reform and the whole child, connecting education to real-life, to the wholeness of the world in a deep,
meaningful, engaging fashion that transforms the human spirit. In her keynote address entitled, Blessed Unrest: The Power of Unreasonable People to Change the World, at the 2008 National Consortium of Specialized Secondary schools of Mathematics, Science, and Technology education in this world? What will it take to stop the erosion of our children’s minds and the quality of their critical and creative thinking? What will it take to ignite and nurture their desire to be pioneers and to advance the STEM frontier and the human condition (Blessed Unrest:The Power of Unreasonable, 2008).

In her speech she focused on 3 systemic actions that are needed in order to answer those questions, 1.) Transforming the math and science that is taught in school to real math and science. 2.) Transforming the way math and science are learned so that children are immersed in the knowledge, skills, and habit of mind essential for real science. 3). Transforming our nation’s system of STEM education so that innovation is ignited and sustained and the language of math and science is spoken and understood by all Americans. Dr. Marshall contends that our students are experiencing science as a huge amount of content and information that the teachers feel is important, with no time for exploration, devoid of wonder and awe. Science in our schools is isolated from other disciplines, its social context and detached from the human experience. To educate our children as pioneers, she says requires immersion in meaning, exploration, interdependence, trust and not fear. We must transform our system of STEM education to one that is stimulating, creates synergies among stakeholders, ignites and supports innovation, nationally and globally.

In 2007 the National Academy of Science, National Academy of Engineering, and the Institute of Medicine published the report, “Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.” The report outlined the position of the
United States in the global world economy, and it was found that there was a weakening of
science, technology, engineering, and math that would erode the ability of U.S. citizens to
compete for the higher skilled, higher wage jobs. The committee looked at the national and
international trends and made recommendations involving hiring more teachers, additional
funding for research and grants, increasing the number of graduate students in the STEM areas,
skills-based preferential immigration option, tax incentives for U.S. based innovations, and many
more.

President George W. Bush quickly passed the America Competes Act, which is referred to as
the STEM ACT, legislation which was enacted and funds authorized to help prepare students and
teachers in math and science from elementary to college. Educators and artists began to look at
the arts – science connection and talk about a STEAM movement emerged. One of the most
important events to bring attention to the STEAM movement was the President’s committee
report in 2011, “Reinvesting in Arts Education: Winning America’s Future through Creative
Schools”

There is a movement initiated by the Rhode Island School of Design to include the Arts in the
Science, Technology, Engineering, and Math (STEM) educational conversation. The goal of the
movement is to combine the technical skills of STEM with the design and artistry of the arts to
create and innovate. The perfect pairing, if you will, for solving 21st century problems in the
United States and all over the world. Arts students may not be cognizant that their important skill
sets are valuable and needed to keep our country viable. The STEAM movement inspires this
dialogue and offers promise as educators struggle to engage students and grow the quality of
their thinking, synthesizing, and problem-solving abilities.
The arts develop valuable skills that meld very nicely with the STEM fields, skills such as observation, visual thinking, and the ability to recognize patterns. Habits of thought and action such as practicing, persevering, trial and error and problem-solving. Numerous studies have found that the arts enhances scientific ability and that the most noted and successful scientists overwhelmingly engage in the arts at rates higher than their peers. The integration of science and the arts must be a high priority if we want to produce students capable of creative participation (Root-Bernstein, R & Root-Bernstein, M., 2013).

Students in arts schools have the opportunity to build their capacity in the 4 C’s, creativity, collaboration, critical thinking, and communication skills. Arts education develops creativity, greater flexibility, adaptability, and reasoning skills in thinking. The very nature of theatre, dance, and music builds collaboration and communication skills. Students who participate in the arts develop a strong sense of identity and confidence. There is no panacea but the artistic process and the scientific method are more similar than dissimilar. Both are about exploration of ideas and possibilities. Both have a “process” and a “product” aspect to them. And both require students to engage in creative and critical thinking that supports collaborative learning (“Artsedge, https://artsedge.kennedy-ceer.org/educators/how-to/growing-from-stem-to-steam.”).

Allowing students to use artistic methods to show their understanding of scientific concepts can help improve student engagement and their self-efficacy in STEM fields. Combining the two also shows students how both the arts and science move to examine, explain, and discover the world in which we live. They both focus on refining the human condition, creating beauty and moving us forward. The creative process requires ingenuity, determination, perseverance, and discipline. The arts also help students realize the personal satisfaction in creating a product developed from their own imaginations, making something out of nothing, if you will. The
creative effort that it takes to transform an abstract thought into a product is similar in the artistic area and scientific arenas. Providing the right conditions for growing and nurturing creative minds must be an area examined when we think about reforming our educational systems.

Just this week, arts education experienced a breakthrough in the United States congress. According to, “Americans for the Arts”, 2015) U.S Representative Suzanne Bonamici, Democrat from Oregon, offered an amendment to integrate the arts into the nation’s STEM programs and promote a well-rounded education was unanimously approved.

Huston, (2015) wrote an interesting piece in the April edition of Techniques magazine about Career & Technical Education (CTE) and the performing arts. The performing arts is actually under the arts, audio-visual technology, and communications career cluster in CTE. The journal article takes a look at three performers’ who admit to being on a constant high and low with acceptance and rejection in the industry. In this climate that emphasizes the more lucrative jobs that are sky-rocketing in demand, the CTE performing arts domain is struggling. Strategies to stay viable in performing arts education point their students in the directions of technical theatre, and sound and lighting engineers, where growth projections are more favorable. Educators say they talk more about work ethics, professional networking, entrepreneurship and the business side of fine arts. All three performers had their talents encouraged through their lives and had choices other than the life they now lead, however they all agree as one student said, “performing is a full body experience. You feel eyes drawn upon you. You get knocked down. It takes a lot of work, but it’s worth it. Nothing makes me as happy as this.”

Arts-inspired students are unique in the way they can take a concept and create something interesting. Ways of nurturing innovation and creativity are being studied and researched
extensively. Adams, (2005) examines a variety of theories and research on creativity and innovation, what is it, and how we can nurture it in our children and in ourselves? She looks at project or problem-based learning as a novel way to enhance the creative abilities in students. Two programs that formed a partnership, were mentioned, INSEAD School of Business in Fountainebleu, France and Art Center College of Design in Pasadena California. Students participate in both programs in an effort to infuse design and business and to bring about a different way of thinking in both areas. Daniel Pink’s reference to design was mentioned in this piece. In this new conceptual age we can not only innovate products but must they must be functional, beautiful, engaging and infused with design practicality.

Knezek, et al. (2015) takes a look at the gender differences of STEM career interests in a study of middle school students in a project called, Middle Schoolers Out to Change The World. This project was designed to help increase student’s interest in STEM content areas and to increase their interest in STEM careers. Students in this study set out to measure the stand-by power used by appliances in our homes, when the appliance is plugged in but turned off. The students were taught how to measure the power, measured the power in their homes and gathered the data to be put on a spreadsheet at which time an energy conservation plan was created to help lower energy costs.

There were 325 students participating from 6 middle schools in Louisiana. Texas, Min, and Vermont. 157 students were male and 168 students were female. There was a pre-test given prior to the intervention and a post- test given, however the results were analyzed from the post- test only. Results from the Career Interest Questionnaire (CIQ) was used in this study to analyze the data. The CIQ was the dependent variable and there were two other instruments used as predictors, the STEM Semantic survey scale and the Computer Attitude Questionnaire Scale.
The study found that participation in the project had a significant impact on the female participants. Science became more closely aligned with STEM interest and was still aligned two years following. Creative tendencies also played a prominent role for both males and females in career interest. The findings show that STEM career interests can be predicted reasonably well for both males and females, but the strongest indicators may not be the same for both gender. Boy’s creative tendencies and dispositions toward science accounted for 33% of the variance in STEM career interest, while for girls a linear combination of dispositions toward science, creative tendencies, and mathematics was able to explain 36% of the variance in interest in becoming a scientist. Dispositions toward engineering were more closely aligned with an interest toward science in girls than for boys.

Bailey, (2016) argues for STEAM education in an article entitled, “An Artist Argument for STEAM Education”. Mr. Bailey is an industrial designer and the president of an industrial design innovation studio in Michigan. In his work he has seen how innovation works and reasons why it doesn’t work. He came up with 3 arguments for adding the ARTS to STEM. 1.) The technical must recognize the art or beauty in a design and the artist must recognize the science behind why something works. Kids should be exposed to both. 2.) Creating an understanding of art and its emotional appeal is crucial to anyone interested in a technical field. Successful products and ideas not only have a rational appeal but also an emotional appeal. 3.) Learn to embrace eccentricity. Humans have a fear of the unknown. Art and creativity are all about creating something new and different.

Summary

Our educational system has not changed much in the last 100 years, but the world has changed significantly. No more can we expect students to regurgitate information or be fact
finders. The era in which we find ourselves is ripe for creativity and innovation. Students are expected to use their critical thinking to solve world problems and be the inventors that make the world a better place. It is generally accepted that education reform is a must and that the United States must lead the charge in this 21st century economy. Well trained science, technology, engineering and math graduates are essential in helping the United States to be ready for the jobs of the future. However there are not enough of the populous interested in these career areas, and definitely not enough females and other minorities. These left brained subjects will help us to move to improve our communication systems, infrastructure, healthcare systems, technology, etc. but those right-brained components are also essential. There has always been a delineation between the heavy sciences and the arts, but we now see that the combination of the left-brain and right-brain is paramount.

The Rhode Island School of Design and others have fought to add the Arts to the STEM movement. The arts not only add a dimension that is interesting and engaging but provide us with new ways of thinking. Students in the early grades are good candidates for this kind of thinking with an introduction to the sciences in a way that is fun and hands-on. Career Mentoring is one way to help students explore these careers and can be done in person or by the use of technology. We are in a time that is ripe for education reform and must use our resources to bridge any gaps that hinder our young people from moving us forward. Developing students’ interest in STEM is being studied increasingly more than previously, however here was no literature found that specifically targets arts-inspired students and STEM.
Chapter Three: Methodology

Research Questions/Hypothesis

The problem of practice in this study is that the United States has found itself on the bottom of the 21st Century skills and STEM education realm. The advance of science, technology, engineering, and math skills among our youth is paramount to our economic survival. The problem persists because not enough students are inspired and engaged in these subject areas early enough to keep them absorbed through their high school years and beyond. The problem is exacerbated by the fact that half of our population, which are women are the least likely to choose a STEM area for their vocation. To address this problem, I investigated how students who are female, and are inspired by the arts, respond to STEM professionals who serve as mentors and facilitators of hands-on STEM activities. I wanted to investigate the students’ sense of well-being and self-efficacy when exposed to science, technology, engineering, and math. Creativity and innovation are paramount ingredients to successful science, technology, engineering, and math education and work. Research suggests that even in countries with large numbers of highly technical individuals in the STEM areas, the element of creativity is what is missing and needed to think critically to help find solutions and important innovations to world problems. Daniel Pink’s suggestion is that the right-brained people, those using creativity and imagination in combination with the technical, will be those reaching success in this conceptual age.

It is hypothesized in this study that students who have an affinity for the arts, which is steeped in creativity, can realize their worth in the STEM areas with the use of career mentors and hands-on experiences that replicate work in those career areas. We look at Lent, Brown, and Hackett’s Social Cognitive Career Theory, which suggests that individuals develop their sense of
self-efficacy from personal performance, learning by example, social interactions, and how they feel in a situation. Career interests are regulated by self-efficacy and an outcome expectation, which means people will form lasting interests in activities when they experience personal competency and positive outcomes.

The Social Cognitive Career Theory is an example of the trend in career development that looks at a person’s own cognitive abilities when making career choices. Self-direction, using the process of acquiring knowledge, understanding through experiences and sensory feelings all help people compose their own career outcomes. Not only does this theory look at the cognitive processes but also the social aspects of people’s lives, which also have influence over their career choices and perceived abilities (Lent, Brown, & Hackett, 2002).

The Social Cognitive Career Theory originated from Albert Bandura’s Social Cognitive Theory which was developed on 1986. The emphasis was on social influences on learning and behavior. The theory looks at a person’s past experiences and its influences on expectations. The primary concepts of the Social Cognitive Theory are observational learning, behavioral capacity, relationship between behavior and environment, expectations, and interactions between the individual, the environment, and behavior (“The Social Cognitive Theory”, 2016).

In this chapter, the methodology used in the pilot study to explore and analyze the participants’ interests and self-efficacy around the STEM areas prior to and after the career mentoring experiences will be explained. Research questions are reviewed and a description of the research design, site and participants, surveys, data collection, data analysis, round-table discussions, interviews, and conclusions are provided.
Research Questions

Research Question 1: Do arts-inspired students have an interest in a STEM career area prior to participating in career mentoring program?

Hypothesis 1: Arts schools are distinguished by their course offerings in dance, drama, art, and music. It is hypothesized that arts-inspired students look to careers in these areas.

Research Question 2: Does participation in a STEM career mentoring program improve student’s self-efficacy in STEM fields?

Hypothesis 2: It is hypothesized that the students in this study, once exposed to career mentors and hands-on experiences in science technology, engineering, and math, will feel that they can be successful in these career areas.

Research Question 3: Does participation in STEM career mentoring program increase student’s interest in pursuing STEM-related careers?

Hypothesis 3: It is hypothesized that students in this study will discover an interest in the STEM-related careers once they have had experiential learning experiences.

Research Design

In this project, a pilot study was designed to be a small scale version for a larger study which can be used for future research. Baker, (1994) found that a sample size of 10-20% of the sample size is a reasonable number of participants to consider enrolling in a pilot. Using a pilot can be useful in determining the feasibility of a study or major project, to examine the usefulness of a survey, or to give advance warning of any potential weaknesses. A pilot study can test logistics and gather information prior to a larger study.

A quantitative approach using a quasi-experimental research design method was used in this study. In quantitative research the aim is to determine the relationship between an independent variable and a dependent or outcome variable in a population. In this study an intervention or independent variable, which was the career mentor designed lessons, were introduced to the
participants at least four times a week for three weeks. The outcome or dependent variable which resulted from the post survey is illustrated in Appendix C. (Creswell, 2003) states that it is useful to relate the variables to the specific questions on the instrument. One technique is to relate the variables, the research questions, and items on the survey instrument so that a reader can easily determine how the researcher will use the questionnaire items. Table 2.1 is used to illustrate those relationships.

Quasi-experimental designs can take a variety of forms. In this study a one-group pretest-posttest design was used, a single group was measured prior to and after the intervention. This design may have been made stronger with the use of a comparison group that did not get the intervention. Several threats to the internal validity exist that might explain the results on this kind of design. History, maturation, instrument decay, data collector characteristics, data collector bias, testing, statistical regression, attitudes of subjects, and implementation (Fraenkel, & Wallen, 1996). It is recommended that for the larger study, a comparison group be added.

The data collected to answer the questions, do arts-inspired students have an interest in a STEM career area prior to participating in the career mentoring program? Does participation in a STEM career mentoring program improve student’s self-efficacy in STEM fields? Does participation in STEM career mentoring program increase student’s interest in pursuing STEM-related careers?

The participants’ level of interest in the arts was first examined using the College Foundation of North Carolina Career Interest Survey. College Foundation of North Carolina is a non-profit agency that services students and families in North Carolina with information about going and paying for college, they also work with colleges and universities to assist students and families in
the financial aid process. The interest survey was developed based on John Holland’s personality and workplace theory.

Interest inventories take a look at a person’s likes and dislikes, their favorite activities, and their personality. The findings are then compared to the qualities of people who work in specific careers and a match is generated. These kinds of inventories do a significant job at finding the commonalities among people and making suggestions as to what a person may want to pursue as a career. This process of self-assessment, is the first step in the career development process and not to be interpreted as a definitive measure. For the purposes of this study the data collected from the interest inventory was analyzed to identify those students with a leaning toward the arts. There were a total of 13 participants in this study whose scores were highest in the artistic area and 4 participants had higher scores in other career areas.

A quantitative design method was used to determine in quantifiable terms the degree to which the interventions used in the study helped increase the participant’s self-efficacy. Differences in the participants’ self-efficacy before and after the hands-on activities and career mentoring were determined by the scores on the pre and post survey questions on the STEM Career Interest Survey. The STEM Career Interest Survey was designed by Meredith Kier, Margaret Blanchard, Jason Osborne, and Jennifer Albert to be as a pre and post assessment of a person’s self-efficacy, outcome expectations, and personal goals around the areas of science, technology, engineering, and math. The survey consists of the four subscales of science, technology, engineering, and math. Subscales can be used independently or one single overall score from the four subscales, which is what the researcher chose to do in this study. Kier, et al. (2013) suggests that it is defensible and supported for researchers to use all four subscales individually, characterized by
four separate sub-scores, or as a single measure due to the strong correlations between the latent factors. In this research, combining all items into a single overall score reflecting career interests in the STEM field overall was preferred. The single factor method was also the desirable method in determining the extent to which the participants’ self-efficacy changed.

**Pilot Study**

The pilot was conducted over a three week period at the “I AM Complete” summer program for girls in Charlotte, North Carolina. The “I AM Complete” summer program is a 10 week program designed for girls, ages 5-17 years old. The program promotes self-confidence, positive social interaction, and faith by incorporating field trip experiences, educational activities, and physical fitness into their comprehensive program.

The basic components of the pilot program were a career interest survey, pre-STEM Career Interest Survey, round-table discussions to give participants background information about the STEM and 21st Century Skills, Steps to Career Development, STEM vs STEAM, and Post-Activity Q/A, and a post STEM self-efficacy assessment. Each day the participants would participate in either a science, technology, engineering, or math activity facilitated by one of the STEM professionals. At the end of the program the post-STEM Career Interest Survey and an evaluation were given.

**Site and Participants**

The participants for the pilot program were 4th and 5th grade students in the “I Am Complete” summer program. The participants were African-American females. The convenience sampling method was employed in this study. In a convenience sample participants who are the easiest to access are recruited. In this study all students in the 4th and 5th grades in the “I AM Complete”
program were recruited. The convenience sample often suffers from biases, such as under-representation or over-representation of particular groups within the sample. Though all student recruits were in the 4th and 5th grades, four participants’ first career choice designation on the CFNC Career Interest Inventory was other than artistic. The target population for this study included all 4th and 5th grade students in the “I AM Complete” summer program for girls. The program was held at Christian Faith Assembly Church in Charlotte, North Carolina. Charlotte, North Carolina is a large urban city, and the third fastest growing in the United States. The population boasts over one million people and the city has industries such as banking, energy, aviation, biotechnology, film production, and motor sports.

The mission and philosophy of the “I Am Complete” program is to inspire the girls who attend to trust and believe they are worthy. Girls are inspired and encouraged to set goals and pursue their dreams. The camp provides education and social skills training, spiritual development, character building, recreation, and a concentration on over-all wellness. The purpose and vision of the program was a match for the goals of this study. The program’s goal is to provide a fun, educational, and inspirational program for girls, to strengthen their self-confidence, self-assurance. The program’s vision is to be a highly recognized company that inspires girls by developing their qualities and characteristics to become confident and respected ladies in the world (http://www.iamcomplete.info/).

The pilot participants consisted of 17 African-American, 4th and 5th grade girls who were participates in the “I AM Complete” summer program. The participants were from various schools in the Charlotte, North Carolina area. The girls participated in the STEM lessons and discussions designed to help students make the connection between their interests and careers in science, technology, engineering, and math. Four of the 17 recruits failed to complete every part
of the study, the analyzed data results reflect the data from the remaining 13 participants in the study. The career mentors were STEM professionals whose expertise was from a variety of areas. Wayne Fisher is the Elementary Science Specialist for the Charlotte-Mecklenburg School System, Tiffany Bryant-Jackson is the “Girls Go Beyond” specialist for the Hornet’s Nest Girl Scout Council, John Lemmon is the owner of John Lemmon Films Animation Studios, and Ann Rushing is the Education Manager for NC 811, which is a non-profit agency that provides education and communication resources to contractors and others prior to excavation projects.

The career mentor group was chosen because of the commitment they have shown in working with students at career fairs, workshops, career luncheon series and various projects with this researcher. These individuals have the passion and exuberance for their work and that was needed for this pilot program.

Wayne Fisher describes himself as the program and project manager to create a buzz about elementary science for 102 elementary schools in the Charlotte-Mecklenburg School district. Mr. Fisher served as an officer in the US Coast Guard where he worked as an engineering physicist. He later lived outside of London, England, raising his two children while his wife was an officer in the US Navy, which gave him an opportunity to volunteer in the British school system. Upon his families return to the US, he taught high school physics until he accepted the challenge of building leadership capacity for elementary science. He is currently the President-Elect for the North Carolina Science Leadership Association.

John Lemmon is the owner of John Lemmon Films, Animation Studio. His studio creates character animation for TV commercials, educational videos and corporate communications. They offer clay animation and 2D (two dimensional) animation, and create custom cross-
platform games. His product, ReadyANIMATOR makes it easy for teachers to teach students how to use stop-motion animation to enhance classroom learning (readyanimator.com).

Tiffany Bryant-Jackson is the “Girls Go Beyond” Specialist with the Hornet’s Nest Girl Scout Council in Charlotte, NC. She creates the STEM and STEAM curriculum for the organization. She also works with the BFF Program, which is a bullying prevention program and The Power of Girls. She also conducts STEM and STEAM workshops for groups in schools and in the community, and brings Girl Scout offerings to at-risk students in their communities.

Ann Rushing is currently the Education Director for NC 811, which is a non-profit agency whose mission is to provide services to contractors, utilities, and the public for the purpose of requesting the location of buried utilities prior to excavation. Ms. Rushing’s experience ranges from Energy Services, Building Inspections & Permitting, Downtown Development, Planning and Land Use. She provided the non-traditional career perspective to our pilot study.

Data Collection

The data obtained in the study were collected during the pilot mentoring program using two sources, The North Carolina College Foundation Career Interest Explorer, and The STEM Career Interest Survey which was used as a pre and post assessment. The North Carolina College Foundation Career Interest Explorer was used to identify the participants with career interests and personalities in categories designated Realistic, Investigative, Social, Artistic, Conventional, or Enterprising. The inventory was created, based on Dr. John Holland’s Theory of Career Choice. His theory states that people all have unique personality types that can be classified into six categories, as well as occupations having unique characteristics that can also be classified into those six categories. The six categories are Realistic, Social, Artistic, Enterprising, Investigative, and Conventional. John Holland theorizes that when a person’s personality
characteristics and their occupational environment are from that same category, they are more likely to find congruence and enjoy their work and subsequently, their lives. We are complex individuals and can be described as two or more of these descriptors, which is considered your Holland Code, so taking just one assessment should not be considered, definitive results. Assessments such as the CFNC Career Interest Explorer should be a first step in a continuing career exploration process.

The CFNC Career Interest Explorer is used to help students identify their personality type based on answers given to several questions, consisting of six different paragraphs about various career types, described are some of the skills and other characteristics about the career. Below the paragraph are questions that ask what the participants like in their daily lives, for instance, “Do you like to work outdoors or Do you like competitive events? Participants are asked to place a “Y” beside the questions that they agree with and to count the number of questions that had a “Y” beside them. Each participant in the pilot study wrote the number of “Y” answers in the box above each paragraph. The participants circled the category with the highest number of “Y”s beside it and marked it their first choice, then second choice, and so on. Participants are then able to look at a sample list of careers within their top three categories. This data was used to distinguish the participants who scored higher in the Artistic category, which were deemed to be art-inspired and those whose scores were high in other categories and less in the Artistic category, which were deemed non-arts-inspired for the purpose of this study.

The STEM Career Interest Survey (STEM – CIS) was used as the pre and post assessment. Meredith Kier, Margaret Blanchard, Jason Osborne, and Jennifer Albert were the creators of the STEM Career Interest Survey (STEM-CIS). The survey was created in response to the call to increase students’ interest in science, technology, engineering, and math in the United States, and
internationally. Many countries around the world are struggling to capture the labor market needed to fill the positions in science, technology, engineering, and math that the research statistics are projecting. The United States, which has held the number one position in innovation, is on the bottom in terms of looking at students matriculating in the STEM fields, with women and minorities trailing far behind. Reports suggest that students are losing interest in the STEM areas by the time they reach high school. The authors started to look at some of the reasons why this decline from elementary to high school is occurring.

The Social Cognitive Career Theory was the theoretical framework by which this predictive model was designed. According to this theory the most influential component to goal setting and action is self-efficacy, which is a person’s belief that he or she is capable of mastering events within their lives. The theory states that outcome expectations affect interest when interacting with self-efficacy (Kier, 2013). The theory has three components, self-efficacy, outcome expectations, and goals. It is believed that we harbor a belief about our ability in a specific task based on personal accomplishments, vicarious experiences, social persuasion, and physical and emotional states. Outcome expectations are said to have been acquired through learning experiences, like cause and effect. These expectations are thought to develop from performing that action in the past, observations of others’ outcomes in a situation, reactions of others, self-approvals and a sense of well-being. Goal setting is deciding on specific outcomes of learning or performance. One factor that seems to strongly effect goal-setting is specificity, which is the degree to which a goal is defined. Studies on goal setting and performance have found that the more difficult a goal is to achieve, the more effort is put into the performance of the task. One study found that those with high self-efficacy tended to set specific goals, whereas those with low self-efficacy tended to set vague ones. Those with specific goals tended to achieve
more, set more challenging goals, progress more, and evaluate personal progress more effectively. The interplay between self-efficacy and outcome expectations is constant. The achievement of a goal increases self-efficacy and improves outcome expectations for the next time.

The STEM-CIS is a 44 question survey that measures participants’ feelings about their abilities in the areas of science, technology, engineering, and math using a Likert scale 1-5 with (1) – strongly disagree, (2) – disagree, (3) Neither agree or disagree, (4) – Agree, (5) – strongly agree. The survey was designed to be used in measuring career interests and the effects of STEM programs on changes to student interest in STEM subjects and careers. According to, Kier, M., et al. it is possible to use this survey in a variety of ways. The four subscales can be used individually, one or more together, or totaled together. For the purposes of this study the four subscales were used together and a single score derived from the survey. Within the subscales are questions that address the factors of the Social Cognitive Career Theory. There were 2 questions on self-efficacy, 2 questions on personal goals, 2 on outcome expectations, 2 measuring interest, 2 measuring contextual supports, and 1 measuring a positive personal input. The statistical data from the assessments were used to determine the success of the actual interventions used in the study. The instrument was designed to be used with middle school students, however, this researcher was given permission from the creators to use it with 4th and 5th grade students, with the same validity and reliability.

The pre and post data were collected and analyzed to determine the effect of the interventions on the participants’ self-efficacy regarding science, technology, engineering, and math. The pre-test was given during the second session, which was recommended by the authors of the STEM Career Interest Survey. It was recommended that participants be given background knowledge of
the subject areas prior to taking the pre-test. The post-test was given at the last session. To
protect the integrity of the data collected and the participants’ confidentiality, pre-tests and post-
tests were given identification numbers and the corresponding identifying information kept
separately. Pre-tests and post-tests were analyzed at the end of the study and all information is
stored and locked, with access only to the researcher.

**Data Analysis**

The pre and post ordinal data collected was based on a 5-point Likert scale designed to
examine the effects of the career mentoring interventions on the participants’ self-efficacy in the
areas of science, technology, engineering, and math. A reliability analysis of the pre and post
surveys was conducted using Cronbach’s Alpha scale. The pre and post percentages were
examined for each participant to determine their initial interest factors and then change over
time. The STEM-CIS was able to quantify important factors of student interest and self-efficacy.
The Likert scale is used to assign quantitative results to qualitative questions

The item correlations on the STEM-CIS were examined in order to drill down to the specific
responses for each item and in each of the four areas, science, technology, engineering, and
math. Each participant’s score was examined, as well as the group of participants’ scores.
The individual pre and post test scores were analyzed and percentages of increase and decrease
in self-efficacy were obtained. A Paired Sample T-Test was used to test my research questions
and hypothesis.

**Interviews**

STEM professionals were interviewed by the researcher after their experience with this pilot
study. Their input was invaluable to this process and the researcher wanted their voices heard.
The goals for the interviews were to explore the professionals’ ideas and reflections around the
STEM and STEAM discussion. The professionals were asked several questions and also given an opportunity to include additional comments. Questions asked were, explain your role in the STEM and/or Arts career areas? Is there STEM in art or art in STEM? How do STEM skills improve on the human-made world? How can we help students who are arts-inspired come to love STEM? Does it matter? The responses helped the researcher seek a deeper understanding as to the climate of thought around the STEAM movement within these different domains.

**Roundtable Discussions/ New Mind Activity**

The roundtable discussions were an important component to the career mentoring piece in that they gave the participants an opportunity to ask questions and reflect on their experiences with the hands-on activities. The time given for discussion was designed to bridge the gap by answering questions and allowing time for reflection. This was also a time to incorporate the New Mind activities which added food for thought. The New Mind activities helped participants to further understand how they could use the concepts of design, story, symphony, empathy, and play, and was used to help generate discussion. Participants were able to take what they had learned in their STEM activity and transfer that learning to one or more of Daniel Pink’s concepts.

**Chapter Four: The Pilot Program**

The Pilot Program for 4th and 5th graders was held for three weeks with participants engaging in lessons, discussions, and hands-on science, technology, engineering, and math activities conducted by STEM career mentors. Most of these activities had a STEM +Arts component.

**Lesson One: Introduction; Why is STEM important? 21st Century Skills!**

CFNC Career Interest Survey

**Lesson Two: Pre-Test (STEM-CIS)/ Discussion**
Lesson Three: Fairy Snot

Supplies
Measuring Cup – 1
Measuring Spoon, ¼ cup – 1
½ Teaspoon (that is not used for food/beverage) – 1
Teaspoon – 1
Food Coloring
Borax – ½ Teaspoon
Cup (that is not used for food/beverage) – 1
Water – about 1 cup
Glue, Elmer’s bottle (4oz) – 1
Bowl (that is not used for food/beverage) – 1
Spoons (that are not used for food/beverage) – 2
Glitter – at least 1 Teaspoon
Sandwich-Size Ziplocs – 1
Goggles – 1

Precautions
1. Do not leave Fairy Snot or its ingredients where a pet or younger sibling could play with it, eat it, or otherwise be harmed by it.
   a. If you get any Borax powder or Fairy Snot into your eyes, rinse well with water immediately. See a doctor if irritation remains.
   b. If any ingredients are eaten, contact Poison Control;
   c. For complete safety information, please visit: https://www.omsi.edu/sites/all/FTP/files/kids/Borax-msds.pdf
2. Do not use cups, bowls, spoons that are used for food/beverage. It is always possible for small amounts of chemicals to remain on them and later be accidentally eaten.
3. When you no longer want it, put it in the trash. Do not pour it down the drain.
4. You can take it out of the bag to play with it AFTER getting your guardian’s permission.
5. Always make sure to wash your hands when you’re done.

Instructions
1. Place your bowl in front of you.
2. Unscrew the lid of the Elmer’s Glue and pour it into the bowl.
3. Measure ½ cup of water (2 of the ¼ cup spoons), and pour it into your bowl with the glue.
4. Use a spoon to stir the water and glue. If you would like your Fairy Snot to have a color, add some food coloring. After the color is added, stir again.
5. If you would like your Fairy Snot to have glitter in it, add at least 1 teaspoon, and stir well.
6. Now pull your cup closer to you. Measure and pour ½ teaspoon of Borax into the cup.
7. With your unused spoon, stir your mixture really well.
8. Next, pour a little bit of the Borax mixture into the glue mixture, stir, then pour a bit more, stir, and so on. You may reach a point where you need to use your hands to squish the solution in order to mix it properly. Keep adding the Borax solution until your Fairy Snot reaches the consistency that you like for slime!
9. When you are done experimenting with your Fairy Snot, place it into a Ziploc bag. Seal the bag, and make sure to store it out of the reach of siblings and pets.
10. Clean-up:
   a. Any Disposable cup, bowl, or spoon that has glue or lots of Borax in it needs to go into the trash.
   b. Everything else can be washed thoroughly with soap and water.

Round Table Discussion / New Mind Activity: Students will use the concept of STORY to explore the many uses of fairy snot. Is story important? Why?

Lesson Four: STEM Animation

Supplies
ReadyANIMATOR
Clay
Construction Paper
Various Objects used to create

The group will be divided into 4 teams with about 4 girls per team. Each team will be given a topic to research and then create a very short (about 1 minute) animated movie about their topic. The movie can be a music video or use slam poetry or some other style. Maybe you create a cheer about your topic. Think about the topic of your movie and think about ways in which you can make your movie more powerful—or make it disappear. How would that change the world?

Discussion Questions:
1. How are your topics similar?
2. Could you invent something using what you learned today?

Team 1: Gravity

Gravity or gravitation is a natural phenomenon by which all things attract one another including stars, planets, galaxies, and even light and sub-atomic particles. Gravity is responsible for the formation of the universe. Without gravity, the universe would be composed only of equally spaced particle. On Earth, gravity gives weight to physical objects and causes the tides.
Gravity has an infinite range, and it cannot be absorbed, transformed, or shielded against. Gravity is the weakest of the four fundamental interactions of nature.

Directions: Make a movie that shows something that you do every day and how it would change if there was a sudden change in gravity.

Team 2: Dissecting Magnets

When a bar magnet is cut in half, each of the resulting pieces is a smaller bar magnet. Even though a magnet is said to have a north pole and a south pole, these two poles cannot be separated from each other.

Directions: Make a movie about slicing magnets in half.

Team 3: How Do Pond Skaters Walk On Water?

Pond skating insects effortlessly skip across the surface of water leaving nothing but a tiny ripple in their wake according to a new study. The insects use the middle of their three pairs of legs to row across the water. They stay afloat thanks to their small weight and the surface tension of water acting like a skin. Note: Surface tension is the elastic tendency of liquids which makes them acquire the least surface area possible. Surface tension is exposed, for example, any time an object or insect (ie. water striders) that is denser than water is able to float or run along the water surface.

Directions: Make a movie about pond skaters and surface tension – perhaps you find a machine that shrinks you to the size of a pond skater. Or maybe you find a way to increase surface tension.

Team 4: Mosquitos and Raindrops

When a raindrop hits a flying mosquito – it’s like a car hitting a person. How does the mosquito survive? It survives because it is so lightweight. When the raindrop hits it, the mosquito gets pushed to the side by the raindrop. If the mosquito was heavier, it would resist the raindrop and get crushed by the raindrop.

Directions: Watch the video starting at 40 seconds, then make a movie about it or go to Youtube.com and search for “mosquito raindrop”. Does this give you an idea for a new kind of drone that can fly in the rain?

Lesson Five: Round-Table Discussion

Career Mentors from STEM fields are positioned at tables and students rotate to each table to ask questions and discuss the various careers.
Interview: John Lemmon, Ready ANIMATOR Studio

1. What is your role in the STEM and/or Arts career areas?

   My company invented animation equipment that enables students to create stop-motion animated movies about STEM topics.

2. Is there STEM in art or art in STEM?

   Both.

   STEM in art: Every art form involves STEM in some way. For instance, the paint used in oil painting is made up of chemicals. Animation involves plane geometry because animated objects move along X and Y axes.

   Art in STEM: All scientific research and innovation needs to be explained to the general public. Art makes those explanations easier to understand and more fun to watch.

3. How do STEM skills improve on the human-made world?

   STEM skills can create technological advances that can make our world safer for our children, cleaner and more peaceful as long as scientific innovations are implemented in ethical ways. Students with liberal arts backgrounds can be leaders in the ethical application of science and technology.

4. How can we help students who are arts-inspired come to love STEM? Does it matter?

   We can help them by unleashing their curiosity about science, to see the art in science and technology.

Lesson Six: Engineering Challenge

Supplies
Spaghetti Noodles
Small and Large Marshmallows
Tennis Ball

Work in teams of 2-3 students to do one of the following tasks:

Task One ---- Build a Pasta Bridge!
Using the materials provided, build a bridge to span a distance of 30 centimeters. The bridge must be wide enough for a tennis ball to roll across!

Task Two --- Build a Tower!
Using the materials provided, build a tower at least 30 centimeters tall to hold a large marshmallow at the top.

**Round Table Discussion/ New Mind Activity:** Students become literate about **Design.** Discussion about design and its pervasive nature throughout our lives. Each student will notice and journal times that they notice design decisions in their lives.

**Lesson Seven: STEM Animation**

**Supplies**
- ReadyANIMATOR
- Clay
- Construction Paper
- Various Objects used to create

The group will be divided into 4 teams with about 4 girls per team. Each team will be given a topic to research and then create a very short (about 1 minute) animated movie about their topic. The movie can be a music video or use slam poetry or some other style. Maybe you create a cheer about your topic. Think about the topic of your movie and think about ways in which you can make your movie more powerful-or make it disappear. How would that change the world?

**Discussion Questions:**
3. How are your topics similar?
4. Could you invent something using what you learned today?

**Team 1: Rotate or Revolve**

What would happen if the earth rotated 10 times faster than it does now?

or

What would happen if the earth revolved around the sun 12 times faster than it does now?

Directions: Research and make a movie that shows your hypothesis.

**Team 2: Gravity**

What would happen if Gravity suddenly became the opposite of gravity?

Directions: Research and make a movie that shows your hypothesis.

**Team 3: Bounce**

What would you do with a material that was 100 times bouncier than a volleyball?
Or a material that would let a trampoline make a person bounce 100 times higher than usual?

Directions: Research and make a movie that shows your hypothesis.

Team 4: – Nanotechnology

If you could shrink to the size of the head of a pin, what would you do, what would you look at, how would it change your life.

Directions: Research and make a movie that shows your hypothesis.

**Lesson Eight: Flicker Investigations**

**Supplies**
- Balloons

Flink means the balloon will not go up or down. It just stays there!

When an object flinks, the forces are balanced. Draw on the balloon the forces acting on the balloon when it flinks. Name the forces.

If the balloon is rising, which force is greater- the up force or the down force?

If the balloon rises quickly, what can you do to slow it down?

What did you learn about forces by playing with your flicker?

Directions: Work in teams of 2-3 students to complete the following challenges:

Task One: Use the materials provided to make the balloon “Flink” for 10 seconds!

Task Two: Now that you know how to make a balloon flink, try the following flinker activities:

A) Use different materials such as cheerios, paper clips, foam peanuts, etc. to make your balloon flink for at least 10 seconds. Record the data!

B) Can you make your balloon rise from the floor to the ceiling in exactly 2.0 seconds? Experiment with your flinker to make that happen!

**Lesson Nine: Roundtable Discussion**
Career Mentors from STEM fields are positioned at tables and students rotate to each table to ask questions and discuss the various careers.

Lesson Ten: Field Experience

Lesson Eleven: Reaction Time Lab

Supplies
Meter Stick

Overview - In this investigation you collect data to determine your reaction time and to review basic concepts about force and motion.

Procedures – You must work with a partner on this activity, but every student collects his/her own data.

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<tr>
<td>Average</td>
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Table 2

Notes – Practice dropping and catching the meter stick several times before recording data. How would that give you a more accurate value for your reaction time?

Analysis and Discussion – In your science notebook answer these questions about this investigation.

A) What is the initial speed of the meter stick before it is released?
B) What force is pulling the meter stick down? Holding it up?
C) Are the forces balanced or unbalanced before the meter stick is dropped?
D) When released, are the forces balanced or unbalanced?
E) What is the effect of an unbalanced force on an object?
F) How fast is the meter stick picking up speed after it is released?

Extra: Use a stopwatch to determine your reaction time. What is the difference between your reaction time using the stopwatch and your reaction time catching the meter stick?

Compare and contrast your visual reaction time to an audible reaction time.
Compare and contrast your left hand vs your right hand reaction times.

**Lesson Twelve: STEM Animation**

**Supplies**
Clay  
Construction Paper  
Various Objects used to create

The group will be divided into 4 teams with about 4 girls per team. Each team will be given a topic to research and then create a very short (about 1 minute) animated movie about their topic. The movie can be a music video or use slam poetry or some other style. Maybe you create a cheer about your topic. Think about the topic of your movie and think about ways in which you can make your movie more powerful—or make it disappear. How would that change the world?

Discussion Questions:
5. How are your topics similar?  
6. Could you invent something using what you learned today?

**Team 1: Friction**

What would happen if there was no friction?

Directions: Research and make a movie that shows your hypothesis.

**Team 2: Solids and Liquids**

If you had a ray gun that would instantly turn a solid into a liquid, what would you do with it?

Directions: Research and make a movie that shows your hypothesis.

**Team 3: 🌈**

Make a funny video about why you love magnetism or geometry or math.

Directions: Research and make a movie that shows your hypothesis.

**Team 4: Saturn**

If you had gone on a vacation to the rings of Saturn, what would you do there?

Directions: Research and make a movie that shows your hypothesis.
Interview: Tiffany Bryant, Hornet’s Nest Girl Scout STEM Specialist

1. What is your role in the STEM and/or Arts career areas?

I am a Girls Go Beyond Specialist with Girl Scouts, Hornet’s Nest Council. In that role I create STEM and STEAM based curriculum that aims to empower girls throughout GSHNC’s underserved areas with the self-confidence to make positive health, education, and career decisions.

2. Is there STEM in art or art in STEM?

Both areas encourage students to think outside the box. You need a level of creativity to do so in science to develop and display experiments. In art you are sometimes required to follow specific instructions depending on what you which to create, similar to a formula.

3. How do STEM skills improve on the human-made world?

STEM skills are constantly at the forefront of innovation. It is through STEM skills that cures are being found, new technology is being developed to overall improve our lives.

4. How can we help students who are arts-inspired come to love STEM? Does It Matter?

The answer is in the presentation. If STEM was taught enthusiastically and presented to children as an adventure, you would build more excitement around it. I believe that is why business focused on this like Mad Science and High Touch High Tech are becoming more and more popular. This is an important change in our educational landscape. You are reenergizing our young inventors of tomorrow, without such an effort, there would be a deficit in STEM career fields.

Lesson Thirteen: Ice-Cream

Supplies

Tablespoon (s) -2 (1 for sugar; 1 for ice cream salt)
Measuring spoon, ½ cup – 1
½ teaspoon – 1
Paper Towels – 1 roll
Cleaning wipes or spray – 1 bottle
Condiment cups or larger – 25 [1 per girl (to eat ice cream from)]
Spoons – 25+(1 per girl)

Hand sanitizer- large bottle

Large cooler(s) – depending on the size of the class and how much perishables will be needed

Optional treat for girls that can’t eat ice cream

Ice cream recipe to take home (1 per girl)

Sugar – 6 tablespoons (1 per group of 4 girls)

Half & Half – 3 cups (1/2 cup per group of 4 girls)

Vanilla – 3 teaspoons (1/2 teaspoon per group of 4 girls)

Rock salt or kosher salt – tablespoons (6 tablespoons per group of 4 girls)

Storage-size Ziploc bags (standard, smaller size) – (2 per group of 4 girls)

Gallon-size Ziploc bags – 2 per group of 4 girls

Disposable cups, 8oz+ (1 to pour dairy and vanilla into and 1 to pour rock salt into) (2 per group of 4 girls)

Large bags of store-bought ice – (1/4 to ½ bag per group of 4 girls-you will need to fill a gallon-size bag halfway full ahead of time per group of supplies)

Trays for passing out cups of supplies

Googles – (1 per girl)

Pre-Lesson

Pre-measure the dairy/vanilla into cups

Pre-measure the rock salt into cups

Pre-measure the sugar into one of each group’s storage-size Ziploc bags.

Fill one of each group’s gallon size Ziplocs halfway full with ice (leave these in the cooler until they are needed).

Introduction:

Today we are going to do some household chemistry. Did you know that cooking and baking food uses chemistry? For example, does ranch dressing grow on a tree? Nope, it’s a mixture of various different substances, like vinegar, milk, and spices. Figuring out which amount of each of those to mix is chemistry!

Some other examples of chemistry we may see in the kitchen are states of matter. Can anyone tell some states of matter? (solid, liquid, gas, plasma). Which one do you often see in your kitchen? We are going to do a bit of dessert chemistry by making ice cream in a bag.

Even if you can’t eat ice cream, you’ll still make it and we have another snack for you to eat. Before anyone touches your materials, you must use hand sanitizer or wash your hands.

(1 person from each group will come up to get supplies for their table).

Everyone will take turns and help each other out with the next steps.

1) One person needs to open and then hold open the bag that has the sugar in it.

2) Another person needs to pour the cup with the milk and vanilla into the sugar bag.
3) The holder of the bag needs to very carefully close and seal the bag; as it is being closed; please try to squeeze the air out of it without spilling the contents. I am going to come around and check that your bag is sealed.
4) Another person to open the other storage-size Ziploc bag; we are going to put the bag with the milk mixture into this bag. Seal the outer bag and squeeze the air out as you do it.
5) Someone will need to come and get a bag or ice from me and the open that bag at your table.
6) Someone else needs to pour the cup of rock salt into the bag of ice, and the holder of the bag needs to kind of mic the ice around as the salt is being poured (show them how to do this without touching the ice).
7) We are now going to put our double-bagged milk into the ice. Seal the ice bag, gently squeezing out the air.
8) Put the ice bag into the gallon-sized bag and squeeze out the air.
9) Students will start gently shaking/massaging our bags so that the milk mixture starts to get really cold.
10) We are going to take turns doing this so that our hands don’t get too cold.

Can anyone tell me how this is going to make ice cream? The ice absorbs/soaks up heat from the milk mixture, so the milk mixture keeps getting colder and colder, eventually becoming more like a solid, or ice cream! While we are doing this, does anyone have a guess why we added the salt to the Ice? It speeds up the heat transfer, allowing us to make ice cream more quickly. Some other questions asked may be: Why doesn’t the ice cream get hard like ice? Answer: the sugar and fat keep the water in the mixture from freezing solid like plain water into a block of ice.

As you roam the room, drop off some paper towels at each table/group.

As your ice cream gets ready, we are going to follow a certain procedure for opening our bags. (Have adults on standby to help with passing out cups and spoons to the girls or ask some of the girls to help with this.

1) One person need to go ahead and open the gallon bags without dumping the ice out).
2) One person needs to remove the smaller bags containing the ice cream and hold them over the paper towel on your table.
3) Go ahead and open the outer bag and remove the inside bag from the outside bag but do not open the inside bag yet.
4) When the outside bag is opening, I need someone else who has not touched any salt to take the inside bag out of the inside bag. Go!
5) After everyone is ready, we will need someone else who has not yet touched salt to be in charge of scooping ice cream into your group’s cups. Be very careful not to touch the outside of the bag because no one wants salty ice cream.
6) As the bag holder and scooper are hard at work, everyone else must work on cleaning up a bit. Once ice cream is ready to eat, we’ll eat and then finish cleaning up.

Lesson Fourteen: Post – Test (STEM – CIS) / Discussion
Chapter Five: “I Am Complete Girls Summer Camp 2015” Study

Research Findings

Research Findings

I Am Complete is a summer program for girls that seeks to encourage self-esteem and help to provide social skills, life skills, spiritual development, character building, mentoring, and recreational services. I Am Complete seeks to nurture girls into young ladies and help them appreciate that they are complete, just as they are. The program was used as a pilot seeking to explore African-American girls’ interest in STEM, once given the opportunity to explore various STEM careers with the help of career mentors. The participants were overwhelmingly arts-inspired and many attend arts magnet schools, though they come from various schools in the city of Charlotte, NC. The College Foundation of North Carolina Career Interest Explorer, which links student’s interests with careers, was used to identify those students who ranked high in the Artistic area of the survey. The STEM Career Interest Survey was used as a pre and post assessment to determine the level of the participants’ self-efficacy prior to and after the interventions. The interventions were conducted by career mentors who are professionals in the science, technology, engineering, and math fields. These career mentors were asked by the researcher to participate in this study because of their expertise in their fields and enthusiasm in working with students at career fairs and other venues that promote STEM knowledge and education. The career mentors have worked in the STEM

There were 17 African-American girls in 4th and 5th grades recruited to participate in this pilot study. The initial sessions were introductory in nature. Students learned from career mentors about STEM and the importance of it expressed in industry and education today. Students participated in sessions that gave them an overview of science, technology, engineering, and
math. Lessons and the various activities continued for three weeks, at which time participants were engaging in simulated activities and discussions with mentors that allowed them to experience the various STEM fields.

The research process began with the hope of instigating a desire among arts-inspired females to know more about a possible future in science, technology, engineering, and math. The STEM fields are the fastest growing and most promising for the future workforce. Research has shown that interest in the STEM fields among students in this country is much lower than students in other countries around the globe. Further, the interest among females and minorities is even lower.

In the creative arts magnet schools, students focus on dance, music, art, and drama as well as their core academic courses. Each of those schools in the Charlotte-Mecklenburg Schools have high low-income populations, which has lead me to believe that those students must become aware of occupations other than those traditionally thought of as artistic careers. The irony is that corporations are clamoring for technical workers who are also creative and innovative. Businesses can teach the technical, but nurturing creativity has been a daunting proposition. I am the counselor at University Park Creative Arts Elementary and host a STEAM WEEK each year that culminates into a career day where professionals present careers and hands-on activities. This pilot study has shown promise that this exposure makes a positive difference in the attitudes of our students. Developing a successful study of this kind with the three creative arts magnet schools in Charlotte-Mecklenburg could add a new dimension to our arts schools.

The STEM movement was initiated out of a need for skilled workers to fill the needs of our corporations and businesses. Researchers have said that science, technology, engineering, and math jobs are flourishing and will be flourishing in the future. Our 21st century economy will
depend on STEM talent to advance the needs of the United States, and because we have become a “global village” we will be charged with helping to solve problems throughout the world. The challenge is that our educational system has not kept up with that need. The students in the United States are at the bottom when we compare test scores and achievement of students around the world.

It has been found that students in the United States, in sufficient numbers, lose interest in the STEM fields in middle-high school and do not pursue these academic fields in college. The numbers are alarming and especially for women and minority students. Consequently, there is a need to expose students to these fields early in their lives and help to create an atmosphere of learning that is interesting and will grasp their attention. There is also a need for people in the STEM fields to be creative and innovative, to use critical thinking, problem solving skills, and the power of observation.

In this study 13 of the 17 students completed all parts of the study. There were 4 participants who did not complete the entire study, so they were not included in the final results. Of those 13 students 9 scored high in artistic interests and 4 scored higher in other areas of the College Foundation of North Carolina Career interest survey. Arts-inspired and non arts-inspired students participated in a 3-week program to expose them to science, technology, engineering, and math activities that were highly engaging. The questions that guided this study were:

1. Do arts-inspired students have an interest in a STEM career area prior to participating in the career mentoring program?
2. Does participation in a STEM career mentoring program improve student’s self-efficacy in STEM fields?
3. Does participation in STEM career mentoring program increase student’s interest in pursuing STEM-related careers?

I used SPSS to conduct a reliability analysis of the STEM Career Interest Survey. The STEM Career Interest Survey consisted of 44 items. Cronbach’s Alpha for the 44 items was .927 and Cronbach’s Alpha based on Standardized items was .926. The STEM Career Interest Survey was found to be highly reliable. Data results showed that out of the participants who completed all phases of the study, overall 61.5% of the participants’ self-efficacy increased after their participation in the activities, 31% actually decreased and 7.6% remained the same. Of the participants who are non-arts inspired, there was a 50% increase and a 50% decrease. Of the participants who are arts-inspired there was a 66.6% increase, 22.2% decrease, and 11.1% remained the same.

To test my research questions and hypothesis, a paired sample t-test was conducted to compare the results from the STEM Career Interest Survey pre-test with the post-test results. The sample t-test is used to test whether population means are significantly different from each other. The results in this study show that there was not a statistically significant difference in the pre-test and post-test.

**Finding One:** Do arts-inspired students have an interest in a STEM career area prior to participating in the career mentoring program?

Arts schools are distinguished by their course offerings in dance, drama, art, and music. It is hypothesized that arts-inspired students look to careers in these areas.

A Descriptive Statistical analysis was conducted on the 13 participants
Minimum = 12   Maximum = 34   (M=23.0000, SD = 6.3164)

**Finding Two:** Does participation in a STEM career mentoring program improve
Students’ self-efficacy in STEM fields?

It is hypothesized that the students in this study, once exposed to career mentors and hands-on experiences in science technology, engineering, and math will feel that they can be successful in these career areas.

A Paired t-test was conducted to compare the STEM pre-test and STEM post-test. This study did not find evidence of a statistically significant difference in the scores for pre-test (M=140.0000, SD=29.15476) and post-test (M=137.9231, SD=6.71056) conditions; t (12) =.297, p =.772.

Finding Three: Does participation in STEM career mentoring program increase students’ interest in pursuing STEM-related careers?

It is hypothesized that students in this study will discover an interest in the STEM-related careers once they have had experiential learning experiences.

A Paired t-test was conducted to compare the STEM pre-test and STEM post-test. This study did not find evidence of a statistically significant difference in the scores for pre-test (M=23.0000, SD=1.72835) and post-test (M=24.9231, SD=1.529946) conditions; t (12) =-1.231, p = .242.

Chapter Six: Discussion of Findings, Considerations for Future Research, References, Tables, Charts, & Appendices

Discussion of Findings

This study gave me the opportunity to work with students to enhance their learning experiences in the area of career development. Students who are inspired by the arts typically have exposure to and envision careers in arts fields. The focus on the science, technology, engineering, and math fields, however, has created an image of a future world with the most promising jobs in those areas. Careers in technical fields will, no doubt, flourish in our technologically advanced 21\textsuperscript{st} century environment, however, the fear is that there will not be an adequate number of students interested in the STEM careers to fill the available jobs. Studies
have shown that students are shying away from these fields, especially after their middle school years, and female and minority students are the least likely to choose a career in a STEM area. Our students are competing with students all over the world, and of the developed countries, the U.S. is at the bottom in the areas of science and math. The need for students to fill these career areas is also a concern among other countries around the world. There will be a need for the highly skilled technical workers, but they must also be creative and innovative. They must possess the soft skills to work collaboratively in teams, be critical thinkers and problem-solvers, have good communication skills, and be globally aware. These workers, according to Daniel Pink, must also use their right-brained (creative) side in order to realize success in this new era.

Today we are in the throes of a new era. This 21st century is an age of fast moving technology, growth, innovation, and promising jobs and opportunities that we can’t yet imagine. We are experiencing a seismic shift and our education system must be aligned and moving forward in order to give our workers of the future the skills needed to be a part of that change. In his book, *A Whole New Mind*, Daniel Pink outlines six essentials for success, Design, Story, Symphony, Empathy, Play, and Meaning. Daniel Pink’s philosophy drove many of our discussions during this study. Students showed interest in this train of thought with good discussion.

Science, Technology, Engineering, and Math (STEM) are the “Nuts & Bolts” in this study. Numerous studies have identified STEM areas as the foundation for the 21st century workforce and consequently for the education of our youth. STEM education, it is said, must be elevated as a national priority and our nation’s future economic prosperity is closely linked with student success in the STEM fields.

I am a counselor at a creative arts magnet school, which happens to also be a Title I school.
We have at least 75% of our students on free and reduced lunch. It occurred to me that our children have part of the sauce that makes for the whole-brained, creativity and imagination. These students must know that and be aware of the opportunities out there for them in this 21st century global world. That is how the study, Arts-inspired students sync their assets to a nuts & bolts world, was born. Our students do realize that there are employment opportunities beyond dance, music, art, and drama in the arts, but I wondered if they understood just how far they could go.

That being said, students who are arts-inspired use those creative skills and possess that flexibility, but the question that needs to be asked is “do they know it?” Do they understand that they have skills that are needed in our 21st century world? These students may potentially choose traditional arts professions, but the knowledge that their creative edge and sensibilities toward innovation are just what is needed in the science, technology, engineering, and math world, may broaden their scope. The purpose of this pilot study was to introduce students who have an affinity for the arts, to career mentors who would conduct experiential STEM activities with the students. I wanted the students to be exposed to the STEM careers in hopes that they would realize that they have career options beyond the traditional arts-related careers. I also wanted their self-efficacy toward these careers to increase as theorized in Lent, Brown, and Hackett’s Social Cognitive Career Theory. SCCT assumes that people are likely to become interested in, choose to pursue, and perform better at activities at which they have strong self-efficacy beliefs. These beliefs come from personal performance accomplishments, observing others, social persuasion, and physical and emotional states experienced while engaged in the particular activity. This pilot program was designed in hopes of replicating this career mentoring process with students at the creative arts schools in Charlotte, NC.
The SCCT belief is that a person’s self-efficacy determines their outcome expectations, how they feel about their chances of being successful in an activity. The choices we make and the persistence and effort that we expend has to do with our belief in a positive outcome.

The third variable has to do with a person’s personal goals. Goals are tied to self-efficacy and outcome expectations. People tend to set goals that are consistent with their views of their personal capabilities and of the outcomes they expect to attain from pursuing a particular course of action. Success or failure in reaching personal goals, in turn, becomes important information that helps to alter or confirm self-efficacy beliefs and outcome expectations (Social Cognitive Career Theory - Career Development).

The research questions posed in this study were, 1. Do arts-inspired students have an interest in a STEM career area prior to participating in the career mentoring program? 2. Does participation in a STEM career mentoring program improve students’ self-efficacy in STEM fields? 3. Does participation in STEM career mentoring program increase students’ interest in pursuing STEM-related careers?

The three hypothesis that were tested were, 1. Arts-inspired students do not have an interest in the STEM areas prior to their participation in the career mentoring program. 2. Participation in a STEM career mentoring program improves student’s self-efficacy. 3. Participation in STEM career mentoring program will increase student’s interest in pursuing STEM-related careers. The data offered limited support for the hypotheses.

The career mentoring program (independent variable) had a limited effect on the dependent variable (STEM Interest Survey results). There are some explanations for what may have occurred. The pilot sample size was small and too small a sample may produce inconclusive
results. This was a convenience sample of 4th and 5th graders who were participants in the “I AM Complete Summer Program.” In any experiment or observation that involves drawing a sample from a population, there is always the possibility that an observed effect would have occurred due to sampling error alone. But if the \( p \)-value is less than the significance level (e.g., \( p < 0.05 \)), then an investigator may conclude that the observed effect actually reflects the characteristics of the population rather than just a sampling error (“Statistical Significance”, n.d.).

The effect of variation is lessened by sample size. That means for a given difference and a given amount of variation, a larger sample is more likely to achieve statistical significance, as shown in this graph:

![Graph showing the relationship between sample size and T-value](image)

This effect also explains why an extremely large sample can produce statistically significant results even when a difference is very small and has no practical consequence (“What Is a t-test”, n.d.).

**Considerations for Future Research**

Further studies are needed in this area. This was a pilot to be replicated with a larger number
of participants who are students in the arts magnet schools in the Charlotte-Mecklenburg Schools. There are approximately 2000 students in the 3 creative arts magnets. The difference in population size will no doubt yield more statistically significant results.

The economic well-being of our nation depends on a skilled workforce and it is incumbent upon our educational systems to find ways to include all of our students. It is my hope that this career mentoring program will have been impactful enough to have left an indelible impression and that the students will carry it with them throughout their lives.

Conclusion

The U.S. and other countries are continuously reshaping elements of the society to be able to meet the demands. It is not known what the future holds in any one area of that society, however, predictions are made based on past and present occurrences. The workforce is a major source of revenue for the population as well as the government, without workers there are no taxes, no schools, no safe roads, etc. The ability for the people to obtain jobs that pay a living wage is paramount to the success of our society.

Researchers have found that in the U.S., young people are not excelling in the subjects in school that will meet the demands for the kinds of jobs that they will face in the future. The science, technology, engineering, and math, high skill jobs are what we are needing now and its forecasted for the future. Education systems are looked upon to help fill that void. Professional Development for teachers and new ways of energizing and delivering to students are pondered.

This research looked at a specific population of students, those that have an affinity for the creative arts, to study. That target population was chosen because of their creative and
imaginative acumen because those kinds of skills are needed in this new workforce. Science, Technology, Engineering, and Math professionals served as career mentors for the students. The mentors developed activities to help the students envision what a job in the STEM area might look like. Activities such as these are blossoming and STEM and STEAM magnet schools are being introduced more and more each school-year.

The arts-inspired students have enormous potential to help fill the void in the STEM workforce. It is the hope of this researcher that we continue to find ways to inspire those students as well as other young people in our society to get ready to meet the demands. Having hosted many career events, I have heard from NASA scientists and others that they didn’t get serious about their careers in their early years, but later in their lives. I am hopeful that we will plant the seeds in young people, early enough so that they will be ready when their times come.

**Protection of Human Subjects**

This research was approved by the Institutional Review Board at Northeastern University. Participation in this project does not present obvious risks to the participants and in no way harmed the student subjects. No student data was made public in any way that would result in any one student being identified. Only the researcher saw the data specifically identifying participants for the purpose of this study. No information will be made public in any way, not published or shared with any other person or entity. Since the subjects are all under the age of eighteen, parents were informed of the study. An information session was conducted to inform and answer questions about the project and the data collected. Students were allowed to not to participate if they chose not to.
References


Knezek, G., Christensen, R., Tyler-Wood, T., & Gibson, D. (2015). Gender Differences in Conceptualizations of STEM Career Interest: Complementary Perspectives from Data


**TABLES**

Table 2.1

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<tr>
<td><strong>Independent Variable #1</strong></td>
<td>Does participation in STEM career mentoring program increase student’s interest in</td>
<td>S3, S5, S7, S9, S10, M3, M5, M7, M9, M10</td>
</tr>
<tr>
<td>pursuing STEM-related careers?</td>
<td>T3, T5, T7, T9, T10</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E3, E5, E7, E9, E10</td>
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</tr>
</tbody>
</table>

**APPENDICES**

Appendix A: College Foundation of North Carolina Career Interest Explorer

STEAM - Elem_Career_Interest_Explorer.pdf
Appendix B: STEM Career Interest Survey

STEM Career Interest Survey – STEM CIS

Name: ____________________  Date: __________________________

Directions: Students will complete the STEM-CIS. Each question is a Likert scale with the following choices: Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5)

Science

S1  I am able to get a good grade in my science class. ____________
S2  I am able to complete my science homework. ____________
S3  I plan to use science in my future career. ____________
S4  I will work hard in my science classes. ____________
S5  If I do well in science classes, it will help me in my future career. __________
S6  My parents would like it if I choose a science career. __________
S7  I am interested in careers that use science. __________
S8  I like my science class __________
S9  I have a role model in a science career. __________
S10 I would feel comfortable talking to people who work in science careers __________
S11 I know of someone in my family who uses science in their career. __________

Mathematics

M1  I am able to get a good grade in my math class. __________
M2  I am able to complete my math homework. __________
M3  I plan to use math in my future career. __________
M4  I will work hard in my math classes. __________
M5  If I do well in math classes, it will help me in my future career. __________
M6  I am interested in careers that use math. __________
M7  I like my math class __________
M8  I have a role model in a math career. __________
M10 I would feel comfortable talking to people who work in math careers __________
M11 I know of someone in my family who uses math in their career. __________

Technology

T1  I am able to do well in activities that involve technology. __________
T2  I am able to learn new technologies. __________
T3  I plan to use technology in my future career. __________
T4  I will learn about new technologies that will help me with school. __________
T5  If I learn about technology, I will be able to do lots of different types of careers. __________
My parents would like it if I choose a technology career.

I like to use technology for class work.

I am interested in careers that use technology.

I have a role model who uses technology in their career.

I would feel comfortable talking to people who work in technology careers.

I know of someone in my family who uses technology in their career.

E1 I am able to do well in activities that involve engineering.

E2 I am able to complete activities that involve engineering.

E3 I plan to use engineering in my future career.

E4 I will work hard on activities at school that involve engineering.

E5 If I learn a lot about engineering, I will be able to do lots of different types of careers.

E6 My parents would like it if I choose and engineering career.

E7 I am interested in careers that involve engineering.

E8 I like activities that involve engineering.

E9 I have a role model in an engineering career.

E10 I would feel comfortable talking to people who are engineers.

E11 I know of someone in my family who is an engineer.
**Appendix C: STEM Career Interest Survey Pre and Post Results**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Arts-Inspired Yes or No</th>
<th>STEM – CIS Pre-Test</th>
<th>STEM – CIS Post Test</th>
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Appendix D: Statistical Analysis

RELIABILITY ANALYSIS - STEM Career Interest Survey

### Reliability Statistics

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<th>Cronbach’s Alpha</th>
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### Descriptive Statistics (Research Q1)

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<td>Valid N (listwise)</td>
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### Paired Sample T-Test (RQ2)

**Paired Samples Statistics**

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**Paired Samples Correlations**

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<td>.044</td>
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Paired Samples Test (Research Q2)

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<th>df</th>
<th>Sig -2 tailed</th>
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PAIRED SAMPLE T-TEST (Research Q3)

Paired Samples Statistics

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<tbody>
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<td></td>
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Paired Samples Correlations

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Paired Samples Test (Research Q3)

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<th>95% Confidence Interval of the Difference</th>
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<th>Sig -2 tailed</th>
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<tr>
<td>Pair 1</td>
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</table>
Appendix E: E-Mail Correspondence from author of STEM-CIS

From: Margaret Blanchard [Meg_Blanchard@ncsu.edu]
Sent: Sunday, December 07, 2014 5:06 PM
To: HUDSON, LYNN B.
Cc: meredith.kier@howard.edu; Meg_Blanchard@ncsu.edu
Subject: Re: STEM Career Interest Survey

Hi Lynn.
That's great.

I also invite you to visit stemcareerawareness.wikispaces.com for videos and scripts and fact sheets and lots of other STEM career stuff! No need to join, all is free and accessible.

We are using the STEM-CIS as a pre and post survey. Giving it online. I think you will get better results if the students have some idea of what engineering and technology are. They probably already are pretty clear on math and science. You might want to give it immediately, then after some initial exposure, then after a whole year, or whatever makes sense for your group.

BTW: any or all of the subscales can be used, as relevant.

Meredith also asked all the students what STEM careers they knew of, making sure all the science, math, etc. were spelled out. Initially, 85 kids that came up with something like a dozen careers. Then at the end, she asked again and it was something like 55 careers. So that is another way to measure some impact.

Meredith had students fill out some fact sheets during explorations, which seemed really helpful. I'm not at my computer, but she can send this or I can tomorrow for you to check out. Her dissertation is also online at NCSU and has some interview protocols, etc. kier, 2013.

Wishing you the best in your work! Holler if we can be of any help.

Meg

On Sunday, December 7, 2014, HUDSON, LYNN B. <lynn.hudson@cms.k12.nc.us> wrote:
Good Afternoon

I am Lynn Hudson, a student in the Ed.D program at Northeastern University. I am creating a pilot program for the 4th and 5th grade students, who happen to be female and African-American, in the after-school program at a creative arts elementary school. This program is designed to encourage the students to sync their assets such as creativity and innovation, to a STEM world.

I would like to use your STEM Career Interest Survey to gauge the impact of the program as it relates to our students' self-efficacy in the STEM areas. Please let me know the procedures for using your survey. Thanks!

Margaret R. Blanchard, PhD
Associate Professor of Science Education
Research Director, The Science House
Graduate Coordinator, Science Education
Alumni Outstanding Extension and Outreach Award
Office Poe 502D
NC State, Campus Box 7801, 2310 Stinson Dr., Raleigh, NC 27695
Meg_Blanchard@ncsu.edu W: 919.515.6906 Cell: 919.457.3410
Act as if what you do makes a difference. It does.
- William James

APPENDIX F : Informed Consent

Northeastern University, College of Professional Studies
Name of Investigator(s): Dr. Lynda Beltz, Ph.D. and Lynn C Hudson, MA
Title of Project: Arts-Inspired Students Sync Their Assets to a Nuts & Bolts World.
   (A Career Mentoring Pilot Program)

Informed Consent to Participate in a Research Study

We are inviting your child to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any question that you have. When you are ready to make a decision, you may tell the researcher if you want your child to participate or not. You do not have to consent if you prefer that your child not participate. Your child also has the right to agree to participate or not. If you and your child agree to participate in the research, the researcher will ask you and your child to sign this statement and will give you a copy to keep.

Why is my child being asked to take part in this research?

We are asking your child to be a part of this study because she is a 4th or 5th grader at the “I Am Complete Summer Camp”.

Why is the research study being done?

The purpose of this research is to help the participants realize their potential in Science, Technology, Engineering, and Math. They will also understand that their background in the Arts will be an asset to them in the future.

What will my child be asked to do?

The participants will be asked to answer a questionnaire about their career aspirations before and after the study. They will participate in learning activities in Science, Technology, Engineering and Math. The activities will be hands-on and engaging.

Where will this take place and how much time will it take?

The study will take place at the Christian Faith Assembly Church in Charlotte, North Carolina, during the “I Am Complete” summer camp. The study will take place during the participants’ enrichment time.

Will there be risk or discomfort to my child?
There will be no risk or discomfort to your child during this study.

**Will my child benefit by being in this research?**

The participants will benefit from this study by being introduced to a wide array of engaging activities in Science, Technology, Engineering and Math. This information may help inform your child’s future.

**Who will see the information about my child?**

The participants, principal researcher, and student researcher will be the only persons to see information about the participants. Participants will receive a copy of their questionnaires.

**Can my child stop participating in this study?**

Your child’s participation is completely voluntary. Participants may end their participation in the study at any time.

**Who can I contact if I have questions or problems?**

If you have any questions about the study feel free to contact Lynn Hudson at 980-343-5178 or Lyn.Hudson@cms.k12.nc.us. You may also contact Dr. Lynda Beltz at 724-853-3062 or L.Beltz@neu.edu

**Who can I contact about my rights as a participant?**
If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

Note to student:

You are being asked to participate in a research study at the “I AM Complete” summer program. If you decide to participate, you will be given a survey to complete before the study and after you have completed the activities associated with the study. The activities will be hands-on in the areas of science, technology, engineering, and math. This form is asking your parents for their consent to allow you to participate in the study, however you must also agree and sign the form below if you are interested in participating. It is absolutely your decision to participate or not to participate in this study.

I agree to have my child take part in this research.

Appendix G: Northeastern University IRB Approval Letter