ABSTRACT

Tonya M. Little, A STUDY TO INCREASE FEMALE MINORITY STEM EFFICACY AND ENGAGEMENT AT THE NORTHEAST ACADEMY FOR AEROSPACE AND ADVANCED TECHNOLOGIES (Under the direction of Dr. James McDowelle) Department of Educational Leadership, April 2019.

This study was designed to improve the Science, Technology, Engineering, and Mathematics (STEM) efficacy and engagement of middle school minority females in a during-school and after-school all-girl peer support group. Studies have shown that there exists a science identity gap where minority female students do not identify with STEM, regardless of their academic achievement (Ballard, 2013). The chances of female students from rural areas succeeding in STEM are less likely because studies suggest that these underserved students are less likely prepared for careers in STEM (Arnett, 2015). A strategic plan was utilized to enhance an existing program that existed as a school club at a public charter school, providing support services for the implementation of hands-on activities in STEM, introduction of STEM role models and a systematic process for addressing skills necessary for social, emotional and behavioral benefits that lead to academic and personal success. This improvement science study enabled school leaders to effectively engage and retain the middle grades minority females in the STEM pipeline. Surveys were utilized to capture the opinions of the middle school, rural female participants as they progressed through STEM engagement, interactions with STEM role models and participation in social, emotional and behavioral learning experiences. After the study, the improvement strategies were considered as effective and can be built upon for future implementation and used as a model to target other demographics in building efficacy and increasing engagement in STEM.

A STUDY TO INCREASE FEMALE MINORITY STEM EFFICACY AND ENGAGEMENT

AT THE NORTHEAST ACADEMY FOR AEROSPACE AND ADVANCED

TECHNOLOGIES

A Dissertation

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Doctor of Education in Educational Leadership

by

Tonya M. Little

April, 2019

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DEDICATION

I would like to dedicate this dissertation to Bernadette Marie Sykes Little, my first teacher and my mother. She departed this world in 1976, leaving a ten-year-old girl on a journey of self-discovery, independence and curiosity. I remember watching my mother as she made interactive books for her Exceptional Children's students. The care she put into making sure every child would have a personal connection to their book and would find their own personal success was inspiring. She had a commitment to her students, despite her debilitating health. Thank you, for teaching me the importance of selflessly giving yourself to those who need you most. Thank you, for leaving me with an understanding that how you walk with the broken speaks louder than how you rise with the great. On some of my darkest days when I question my purpose in this world, I think of my mother making those books and know that my purpose is to continue her legacy as an educator. I hope to inspire students, teachers and community stakeholders. I hope Bernadette's legacies are opportunities for students to make personal connections and find successes. An investment in our youth is the future success of us all.

This dissertation is also dedicated to my grandparents James and Eula Sykes. Granddaddy and Nana, thank you for never giving me the chance to look at the broken pieces, but only the infinite possibilities of masterpieces that come through resiliency and perseverance.

ACKNOWLEDGEMENTS

I am grateful to the people who have made this dissertation possible. I would like to acknowledge my children: TJ, Rashad, Imani and Victoria. You have been the reason I get up every morning and put one foot in front of the other. My career and education has been a journey of improvement and self-efficacy because I wanted each of you to have the life that you deserve. Martha, Von, and Nia Joyner; I will forever be grateful for the time, sacrifices and reliability that you have been in my life. If it was not for you, I would not have been able to achieve my educational and professional goals.

I am thankful for the many teachers, administrators, parents and community stakeholders who showed up and very often stepped out of their comfort zone, taking this journey with me in STEM; exploring robotics, establishing school gardens and hydroponics towers, learning while playing, getting wet and dirty sometimes, hopping on buses and travelling in cars to explore STEM, and never running away when I got that look of determination on my face. We have been on a whirlwind journey of making magic happen for the students of rural northeastern North Carolina.

I am also thankful for my amazing dissertation chairperson, Dr. James McDowelle. Thank you for your patience, guidance and feedback. I will forever appreciate your support, advice and encouragement. Lastly, I would like to acknowledge the girls of Delta Academy and the many students I have worked with in northeastern North Carolina. As I have said to many students, "Do not fall prey to the tyranny of mediocrity, excel! Your zip code, ethnicity, gender or socioeconomic status puts no restraints on your dreams, determination and destiny. You will. You can. You must."

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CHAPTER 1: THE PROBLEM OF PRACTICE

The purpose of this study is to understand how experiences can influence middle grades female minority students' science, technology, engineering and mathematics (STEM) efficacy and engagement at the Northeast Academy for Aerospace and Advanced Technologies (NEAAAT). The data collected will be from a targeted in-school and out-of-school program using the North Carolina State University Maximizing the Impact of STEM Outreach (MISO) Student Attitudes Toward STEM Survey (S-STEM), Student Engagement Instrument (SEI), and a student engagement questionnaire based on the work of Phillip Schlechty (2002). The MISO S-STEM survey can be used to understand how programs have an impact on student engagement and persistence in STEM (Unfried, Faber, Stanhope, & Wiebe, 2015). The SEI measures five subtypes of student engagement. The Schlechty Questionnaire of Classroom Engagement measures levels of engagement along an identified continuum of educational engagement. This study is designed to increase STEM efficacy and engagement of rural, female minority middle school students in a STEM-focused school.

Study Questions

This study asks the following questions:

1. Can a STEM-focused peer group, at NEAAAT, increase self-efficacy perceptions about middle grades female minority students' success in STEM?

2. Can a STEM-focused peer group empower NEAAAT middle grades female minority students to become more engaged in STEM activities by developing the non-cognitive skills necessary for sustainability in STEM; such as creativity, teamwork, perseverance, resilience and motivation to learn?

Women face challenges in sustaining careers in STEM (Williams, 2015). Minority women face even greater challenges and biases (Heck, 2013). Studies have shown that there exists a science identity gap where some minority female students do not identify with STEM, regardless of their academic achievement (Ballard, 2013). The chances of female students from rural areas succeeding in STEM are less likely because studies suggest that these underserved students are less likely prepared for careers in STEM (Arnett, 2015). A strategic plan will be utilized to enhance a program that exists as a school club at NEAAAT, providing support services for the implementation of hands-on activities in STEM, introduction of STEM role models and a systematic process for addressing skills necessary for social, emotional and behavioral benefits that lead to academic and personal success. This improvement science study will enable NEAAAT school leaders to effectively engage and retain the middle grades minority females in the STEM pipeline. Surveys will be utilized to capture the opinions of the middle school, rural female participants as they progress through STEM engagement, interactions with STEM role models and participation in social, emotional and behavioral learning experiences. Percentage of participants participating in during-school and after-school events and grade reports will be analyzed for progress in science and mathematics courses. The number of participant female minority students engaged in summer STEM enrichment opportunities will show proof of their developed STEM identity and will demonstrate confidence in pursuing STEM activities, because of their association with the focus group. An increase in STEM efficacy will be measured using the MISO S-STEM survey. Levels of engagement and characteristics needed for highly engaged learners will be measured using the Schlechty Levels of Engagement Survey.

Significance of Study

Rural K-12 students face many obstacles in gaining access to quality STEM education. Rural students are at a deficit, regardless of race, ethnicity and socioeconomic status; requiring their teachers and school systems to seek innovative ways to close these opportunity gaps (Buffington, 2017). It is with this understanding that all rural students are at risk, due to limited national attention focused on rural STEM equity research, rural poverty, declining college enrollment, and teacher retention (Buffington, 2017). The work of this study, focusing on one of the at-risk demographic groups, will hopefully shed light on how we can help all underserved and underrepresented groups become successful. This study will inform future STEM engagement and outreach at NEAAAT. It is important work, not only for female, minority students; but for supporting all students in increasing interest and confidence in STEM.

Naming and Framing the Problem

This study is designed to improve the engagement of rural, female minority middle school students in STEM and increase their STEM efficacy in a STEM-focused public charter school. Research has shown that even though females perform as well as males in mathematics and science in K-12, many females lose interest in STEM by the age of fifteen (Williams, 2017). According to American College Testing (ACT) data, not enough students in the United States are prepared for STEM opportunities and underserved students are at a greater disadvantage (ACT, 2017). The ACT definition of underserved students includes students who are in one of the following categories; minority (race/ethnicity is African American, American Indian/ Alaskan Native, Hispanic/Latino, or Native Hawaiian/ Pacific Islander); low income, combined parental income is less than or equal to $36,000; and first generation in college, highest parental education level is high school diploma or less (ACT, 2017).

This study focuses on a STEM-focused public charter school located in rural, northeastern North Carolina, the Northeast Academy for Aerospace and Advanced Technologies (NEAAAT). The school has struggled with minority recruitment and retention of minority students. In the 2017-2018 school year, there were thirty-one withdrawals from school. Thirty-two percent of these withdrawals were minority students. Twenty-five percent of the withdrawals were minority females. Reasons for withdrawals included poor academic performance (12%) return to friends (63%), and relocation of the family (25%). The STEM-focused school serviced 350 students during the 2017-2018 school year. The racial demographics of the school are as follows; 1% are Asian, less than 1% Native Hawaiian/Pacific Islander, 1.1% American Indian/Alaskan Native, 4% Hispanic/Latino, 6 % Multiracial, 17% African American, and 70% White. 30.14% of the students are identified as living in poverty (see Figure 1).

During the 2017-2018 school year, NEAAAT had a Chief Executive Officer (CEO) that served as the superintendent of the school. The CEO is a White male. I was the Chief Operations Officer (COO) serving in the capacity of principal of the middle grades (7th -8th grade) and high school (9th – 11th grade), assistant principal, transportation coordinator, Beginning Teacher Support, and Career and Technical Education Administrator (see Figure 2).

The school underwent a strategic reorganization of the school's leadership. An outside consulting firm was contracted to inform the reorganization of the school's leadership structure, examine the school's mission, five-year strategic plan, and the capacity to build distributive leadership. Because of this exploration, the school's CEO remained as the leader of the school and I, the COO, am now the Executive Director of STEM. This change was suited for my knowledge and experience in developing and leading STEM initiatives. This restructuring enabled me to further develop the STEM identity of the school. The school now has a Principal,

Rural Public Charter STEM School Ethnicity of Students

American Indian/Alaskan Native, 1.10%

Hispanic/Latino, 4%

Multiracial, 6.30%

African American, 17.00%

White, 71.30%

Native Hawaiian/Pacific Islander, 1%

Asian, 0%
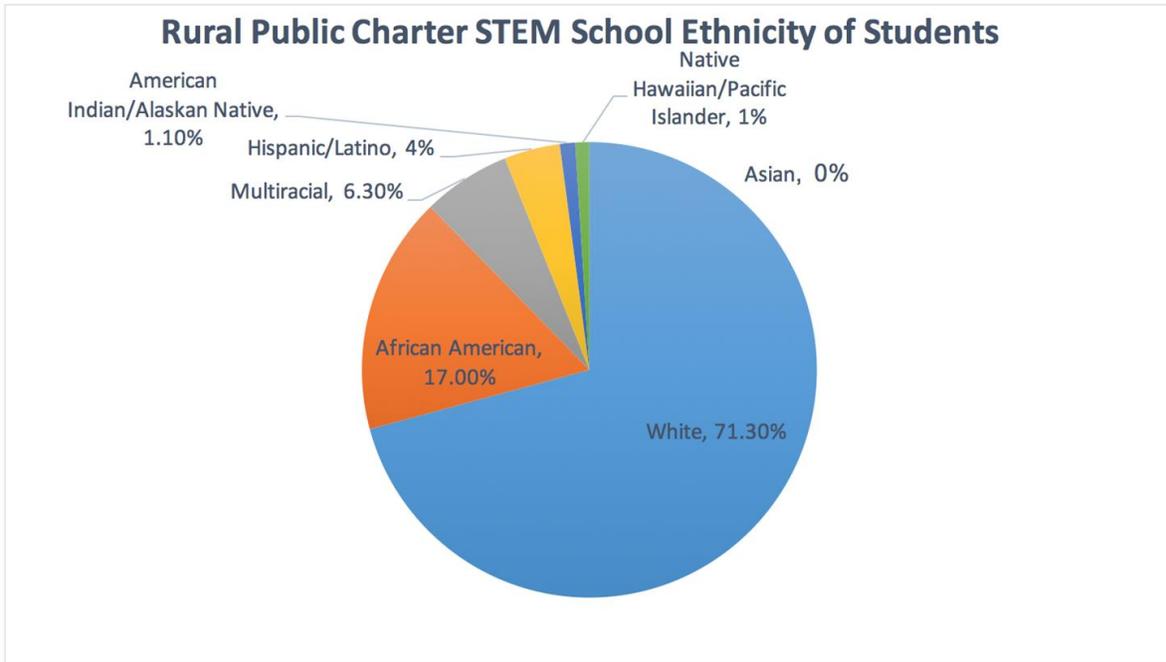
Note. Adapted from the 2017-2018 William R. Kenan Jr. Charitable Trust Grant Report Submitted by the Northeast Academy for Aerospace and Advanced Technologies

Figure 1. Ethnicity of NEAAAT students (Adapted from NEAAAT school data 2017-2018).

Northeastern Academy for Aerospace and Advanced Technology Ethnicity of Teachers

Hispanic/Latin American 5%

African American 21%

White 74%
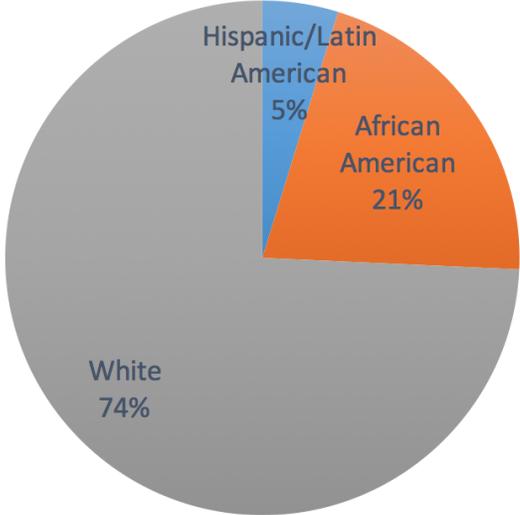
Figure 2 Ethnicity of Northeast Academy for Aerospace and Advanced Technology Instructional Coaches

Figure 2. Ethnicity of NEAAAT instructional coaches (Adapted from NEAAAT school data 2017-2018).

who is a White male and an Assistant Principal, who is an African American female. There were eighteen teachers during the 2017-2018 school year; 21% of the teachers were African American, 5% of the teachers were Hispanic/Latin American, 74% of the teachers were White. As the Executive Director of STEM, I have worked to strengthen the STEM identity of the school by aligning the school's practices to the North Carolina Department of Public Instruction's (NCDPI) STEM Attribute Implementation Rubric (see Appendix B). The STEM Attribute Implementation Rubric identifies eleven attributes that schools should achieve to develop an effective STEM school. In my first year as the Executive Director of STEM, I focused on the following attributes of the rubric - project-based learning with integrated content across STEM subjects; connections to effective in- and out-of-school STEM programs; and outreach, support and focus on underserved, especially females, minorities, and economically disadvantaged (see Appendix B). It is the intent of the school's leadership plan to achieve a model status for each of the attributes in the next two years.

Setting

NEAAAT is in a rural county in northeastern North Carolina. The county is predominately agricultural, with cotton, tobacco and soybean dominating the landscape. The area is struggling with economic decline. Pasquotank County is the fifth smallest county in North Carolina, with a population of 39,909 estimated in 2016 (NCDOC, 2018).

The national unemployment rate for May 2018 was 3.9% (NCDOC, 2018) Pasquotank County's unemployment rate rises higher than the national average at 5.1% (NCDOC, 2018). According to the Elizabeth City Economic Development Commission, the top five employers of the county are the school system (1,000+ employees), Sentara Albemarle Medical Center (500-999 employees), the United States Coast Guard (500-999 employees), Elizabeth City State

University (500-999 employees), and Walmart (250-499 employees) Approximately 85.4% of the counties' residents graduate with a high school degree and 18.9% of the population has at least a bachelor's degree (NCDOC, 2018). One of the links to fortify the potential for economic growth is investing in the students of NEAAAT. The school has identified three areas that STEM skills are needed to fill jobs in a sixty-mile radius of the school, covering areas in northeastern North Carolina and southeastern Virginia; health care, aviation, and computer science with a focus on cybersecurity. It is the goal of the school to provide opportunities for students, as early as sixth grade, in each of these areas providing the opportunity to focus on one of the pathways in high school.

Many minority youth from high-risk communities are in a constant battle with their possible selves, for fear of marginalization by their peers. Studies have shown that for African American youth, developing a sense of self and one's place in the world is challenging (Gullan, Hoffman, & Leff, 2011). Some female students develop positive science identities through after school and out-of-school STEM activities, but still struggle with a STEM identity because of negative experiences in their regular classroom environments (Tan, Barton, Kang, & O'Neil, 2013). Oyserman, Bybee, and Terry (2006) showed that group-based intervention can strengthen and support academic possible selves and increase engagement in academic settings. Individual, group or culturally-focused interventions have had positive effects on the positive identity of youth because of role-model identity and shared-identity developed within the group. Could a school-based intervention enable middle grades female minority students to build confident STEM identities, enabling them to visualize themselves having successful careers as biofuels research scientists, software engineers, computer programmers, nanotechnologists, environmental lawyers, marine biologists, statisticians and much more? The top ten occupations

that are predicted to grow the fastest in the next ten years, according to the United States
Department of Labor, Bureau of Labor Statistics (2018), are:

1. Solar photovoltaic installers

2. Wind turbine service technicians

3. Home health aides

4. Personal care aides

5. Physician assistants

6. Nurse practitioners

7. Statisticians

8. Physical therapist's assistants

9. Software developers, applications

10. Mathematicians

These occupations require STEM education and training. Education focused on STEM
has gained popularity in the United States. The 2007 Rising Above the Gathering Storm report
called for an increased focus on recruiting, training and increasing the skills of K-12 STEM
educators and increasing American students who are prepared to enter college and graduate with
a STEM degree (STEM in Action, 2011). In November 2009, President Obama launched the
"Educate to Innovate" Campaign for Excellence in STEM. The program was expanded in 2010,
announcing industry partners who committed millions of dollars to attract, develop, train, reward
and retain STEM educators. Despite new STEM initiatives and some signs of growth, student
aptitude in STEM is lackluster. According to the U.S. News/Raytheon STEM Index, U.S.
students' interest in STEM reached a low point in 2004, levels steadily climbed until 2009 and
then fell again. Between 2009 and 2013, interests declined again and are now below where they

were in 2000 (Alphonse, 2014). Engaging students in hands-on learning, providing learning experiences that rely on collaboration and teamwork, scaffolding experiences that are based on real-world problems, and introducing role models that enable students to identify with STEM professionals are recommendations that have been made to engage elementary and middle school learners who are not typically represented in STEM (Baine, 2008). STEM identity at the age of fourteen can predict whether the student will persevere with STEM through college (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2012). Strategies to engage females in STEM have typically focused on *fitting in*, but it has been proven that organizational change and restructuring can help female students feel more empowered in STEM (DiBenedetto, 2015). According to the Social Cognitive Career Theory (SCCT), as described by Lent, Brown and Hackett (1994), if an educational organization invests in understanding students' cultural identity, pays attention to the opportunity structures and provides support systems; then, there will be a positive impact on learning, persistence in pursuit of career goals and self-efficacy (Lent et al., 1994).

In summary, this study will utilize organizational change and strategies to engage rural, minority, female students in STEM. Co-curricular partnerships have been shown to complement academic curriculum, reinforce concepts taught in school without replicating classroom procedures, and provide access to mentors, role models and resources not readily available to schools (Little, 2013). This study will show that

1. for schools to have a STEM identity, it is important that there is a focused effort to engage typically underserved populations in STEM. Because these populations have been historically at the peripheral of STEM opportunities, it is important to have concerted efforts of quality STEM engagement, and

2. in tandem with STEM engagement, underserved populations should be engaged in activities that build communities of learners that promote student success, character, resilience, wellness and most of all - efficacy.

Interventions

During twenty-one years as a classroom teacher and four years as a school administrator, I have participated in many STEM initiatives. After several years of working with students in an after-school science club, I began to see the need for, and the impact, STEM enrichment activities had in the lives of minority children. This motivated me to pursue STEM partnerships, utilize authentic tools of STEM, engage more students in STEM competitions and learn more about STEM enrichment opportunities for students. With my increased attendance at STEM events, it was observed that there were very few female minority students participating and more underserved minority students without the resources to participate in after school STEM activities. It was at that time that I decided to partner with an organization that would assist schools with getting minority female students involved in STEM activities. I partnered with Delta Sigma Theta Sorority, Inc., a nationally recognized not-for-profit organization whose purpose is to aid and support through established programs in local communities throughout the world. Since its founding more than 200,000 women have joined the organization. The organization is a sisterhood of predominantly Black, college educated women. The sorority currently has 1,000 collegiate and alumnae chapters located in the United States, England, Japan (Tokyo and Okinawa), Germany, the Virgin Islands, Bermuda, the Bahamas, Jamaica and the Republic of Korea. Since 1996, the organization has addressed the needs of young females ages eleven through fourteen through its Delta Academy community outreach program. Working in a rural community, I found success in partnering with local programs that had a STEM focus and

established STEM programs such as 4-H, local institutions of higher education and STEM businesses and industries. I utilized these agencies to provide STEM extracurricular opportunities to supplement resources of the local school system and provide local, regional a state STEM opportunities for students and parents.

The thought was that Delta Academy would provide opportunities to a rural middle school to create greater interest and passion in minority females for STEM, nurture those that had an innate interest in STEM, and provide teachers with hands-on activities that could be taught in the classroom. The goal was to increase the number of female minority students that were successful academically in STEM classes and foster confidence in the girls to pursue STEM opportunities beyond their school.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

In many ways, the advancement of STEM education appears to have grown from a concern for the low number of future professionals to fill STEM jobs and careers and economic and educational competitiveness (Brown, Brown, Reardon, & Merrill, 2011). The proponents of STEM education believe that by increasing math and science requirements in schools, along with infusing technology and engineering concepts, students will perform better and be better prepared for advanced education or jobs in STEM fields (often referred to as the STEM pipeline). The lasting result would be that the United States would again rise to the top of international rankings. While the outcome remains to be seen, many in the field of technology education have taken the idea of STEM education and have attempted to either integrate more math and science into their courses or highlight the ways in which those concepts were already being integrated. The believed benefits of doing so are that students experience real-world problems making more connections to STEM fields and the ever-changing workforce, sparking interest in STEM fields. Creating these links earlier in the students' educational careers could potentially result in an increased number of students entering fields associated with STEM. Research concludes that STEM education is not well understood and there is not a clear vision for STEM education even amongst those who believe it is important (Brown et al., 2011).

Historical Perspective

Drew (2015) provides a current historical perspective on STEM education looking mostly at student achievement. He supports the mediocre STEM environment with results from Program for International Student Assessment (PISA), conducted by the Organization for Economic Cooperation and Development (OECD); Trends in International Mathematics and Science Study

(TIMSS); Progress in International Literacy Study (PIRLS); and the Adult Literacy and Life Skills Survey (ALL). Drew acknowledges that U.S. performance has improved slightly for high school students in both mathematics and science and that American students perform well on advanced analytical reasoning. And while the US has high percentages of 18-year-olds in school, low percentages of them study advanced mathematics and science; more remains to be done.

STEM education (and competitiveness) issues have received a lot of attention in recent years (Kuenzi, 2008). Several high-profile proposals were forwarded by the academic and business communities. In February of 2006, the President released the American Competitiveness Initiative. During the 109th Congress, three somewhat modest STEM education programs were passed and signed into law. Finally, in the spring and summer of 2007, some of the major STEM education legislative proposals were combined into the America Competes Act of 2007, passed by the 110th Congress and signed by the President on August 9, 2007.This report provides the background and context to understand these legislative developments. The report first presents data on the state of STEM education in the United States. It then examines the federal role in promoting STEM education. The report concludes with a discussion of the legislative actions recently taken to address federal STEM education policy.

Women Underrepresented in STEM

Women are underrepresented in STEM majors and careers in most industrialized countries around the world (Blickenstaff, 2005). Women face barriers in STEM that may be part of the STEM culture (Blickenstaff, 2005). Recommendations for reform in science education to address this problem have been provided to plug the leaky STEM pipeline. It is important for a female identity in STEM. The lack of female STEM presence has affected research outcomes,

created gender biases and poses implications for the effects on healthcare, education, and technology influences.

There are a disproportionate number of African American girls suspended from school; the low expectations from teachers; the low numbers of African American girls participating in STEM activities. Kunjufu (2014) offers suggestions for increasing the numbers of African American girls in pursuing STEM degrees and careers. Kunjufu (2014) identifies current toys and technologies to engage young African American girls in STEM, analyzes learning styles and addresses STEM relevance to the African American community.

It is often stated that females are not attracted to STEM fields because STEM work has been stereotyped as masculine, impersonal, and individualistic. These reasons did not emerge in this study. For females, whose science identities diminished during middle school, the social dimensions of their science education were the most critical influence—whether their teachers and peers recognized them as science thinkers and doers. This recognition, or lack thereof, greatly contributed to females' negative experiences, and were mediated by racialized and classed assumptions about their abilities and potential for achievement. The results of this study confirm that supporting identity work with females and underrepresented populations is key to sustaining their interest and success in STEM (Nicholls et al., 2010).

Freeman Hrabowski, President of University of Maryland, Baltimore County, focuses his research on minority participation and performance in science and mathematics education. Hrabowski (2013) said that we need to change the culture of STEM teaching. We need to teach students how to use technology effectively, how to work in groups effectively, how to collaborate and most importantly how to ask the right questions. STEM teachers should develop a culture of inquiry that encourages curiosity and questioning. This will engage his students in

the learning process, push his students to think independently,and empower them to seek answers independently. Hrabowski says let students explore, understand, struggle with learning and then explicate through dialogue for understanding. He further states that scaffolding teaching to support students in independent learning is essential.

There are more women and minorities working in the biological sciences, so they do better in these areas because they see evidences of success. Underrepresented students "see their reflection" in these disciplines. Other STEM fields have less diversity, leading to students feeling isolated. One way to improve this disparity is to provide mentors within the programs (teacher-student, student-student, and even STEM clubs. I call it a "posse" model, bringing students together to form their own STEM identity. Some students feel like "imposters" when they are part of the isolated few, outside of their identity group participating in STEM activities. Mentoring and redefining STEM culture enables students to not feel excluded from their peers, or feel like imposters.

Results of four experiments showed that women tended to perform as well as men on a math test when the test was administered by a woman with high competence in math, but they performed more poorly (and showed a lower state of self-esteem) when the test was administered by a man (Marx, Staple, & Muller, 2005). Results indicated that these effects were due to the perceived competence, and not just the gender, of the experimenter. These studies will provide insight to the crucial role STEM role models and mentors play in STEM achievement.

Murphy, Steele, and Gross (2007) examined the cues hypothesis, which holds that situational cues, such as a setting's features and organization, can make potential targets vulnerable to social identity threat. Objective and subjective measures of identity threat were collected from male and female math, science, and engineering (MSE) majors who watched an

MSE conference video depicting either an unbalanced ratio of men to women or a balanced ratio. Women who viewed the unbalanced video exhibited more cognitive and physiological vigilance, and reported a lower sense of belonging and less desire to participate in the conference, than did women who viewed the gender-balanced video. Men were unaffected by this situational cue. The implications for understanding vulnerability to social identity threat, particularly among women in MSE settings, are important to the current research. Stereotype threat (Steele, 2010) can lead minority females to not decide to pursue STEM classes, degrees and occupations because they fear failure. Minority females in STEM have reported increased anxiety and fear of embarrassment because of stereotype threat. Forbes' interview (Stereotype threat and the leaky pipeline in STEM, 2014) revealed that stereotype threat can have a physical manifestation in the brain. When women are in stereotype neutral situations, when they are not reminded of their minority status, their brains look identical to male brains when performing the same tasks. Under the influence of a stereotype threat, they perform differently and there is a difference in neural functioning. This is interesting to the current study of middle school girls, because middle school girls are at a neurological developmental stage in which the brain is experiencing many different adolescent changes. Adolescents are moving from concrete to abstract thinking and to the beginnings of metacognition (the active monitoring and regulation of thinking processes). They are developing skills in deductive reasoning, problem solving, and generalizing. Would STEM stereotype threat situations influence the development of adolescent girls? Culturally responsive teaching (Gay, 2010) will guide practices in working with the middle school female students in STEM. The specific components of this approach to teaching are based on research findings, theoretical claims, practical experiences, and personal stories of educators researching and working with underachieving African American, Asian, Latino, and Native American students.

These data were produced by individuals from a wide variety of backgrounds developing a knowledge base about cultural diversity, including ethnic and cultural diversity content in the curriculum, demonstrating caring and building learning communities, communicating with ethnically diverse students, and responding to ethnic diversity in the delivery of instruction. Culturally responsive teaching is defined as using the cultural characteristics, experiences, and perspectives of ethnically diverse students as mechanisms for teaching them more effectively. It assumes that when academic knowledge and skills are situated within the lived experiences and frames of reference of students, they are more personally meaningful, have higher interest appeal, and are learned more easily and thoroughly.

Addressing the Problem

Rajagopal (2011) addresses effective teaching and student motivation. The strategies employed by the author with urban youth included methodology to close the gaps in economic and racial achievement with culturally relevant instruction. Albeit the author taught urban youth, there are great similarities in the struggles of underrepresented youth regardless of geography. The author suggests using culturally relevant materials, delivery of constant and consistent assessments, creative delivery techniques and a rewards system. Rajagopal's book (2011) is relevant to the current study to provide solutions to STEM teachers to engage underrepresented populations.

The Center for Research, Evaluation, and Assessment (REA) at the Lawrence Hall of Science, University of California, Berkeley undertook a 10-year retrospective study of Project Exploration programming and participation by nearly 1,000 Chicago public school students. The survey and follow-up interviews attempted to surface factors that affected students' decisions to get involved and stay involved with science. Key findings from the REA study, for increasing

student involvement, include the following: increased science capacity; positive youth development; and engagement in a community of practice that nurtured relationships and helped students learn from one another, envision careers in science, and feel good about their futures (Chi et al., 2010).

Vega (2014) focuses on developing a growth mindset and perseverance. For students to feel capable of achieving academic goals there are four sources, that will empower student achievement. (1) Mastery experiences, which are prior experiences of succeeding at similar tasks; (2) vicarious experiences: seeing or being aware of others who have been successful at similar tasks; (3) verbal and social persuasion: the extent to which students are encouraged to believe that they will be successful; and (4) emotional state, feelings that students experience around the task domain. Vega's article places emphasis on the premise that success builds capability. The article also draws attention to the belief that intelligence is malleable. This article could easily be used as a source for investigating the persistence of middle school minority females in STEM because it addresses sustained efforts, focus and persistence. These are concrete methods for reducing stereotype threats that may affect academic performance.

A consensus reached by practitioners, youth development advocates and youth development learners has resulted in a short list of a specific set of outcomes for after-school programs: caring and compassion, character, competence in academic, social and vocational arenas, confidence, and connection (Roth & Brooks-Gunn, 2000). With measures of the outcomes specified, a model would then indicate structural features that are designed to affect those outcomes. According to Eccles and Templeton (2001), features of successful programs in STEM include:

1. Adequate provision for physical and psychological safety.

2. Developmentally appropriate levels of structure and adult supervision.

3. Supportive and respectful relationships among peers.

4. Supportive relationships with adults.

5. Opportunities to develop a strong sense of belonging.

6. Opportunities to experience mastery and mattering.

7. Opportunities to learn cognitive and non-cognitive skills essential for success.

8. Strong positive social norms

After-school programs have the potential for, and a history of, engaging children in experiences that can transform their lives academically, socially, and professionally. In a rural setting, where underserved populations often do not have the resources to participate in after-school programs a STEM program that is not only an after-school extracurricular program, but also embedded as a during-school program offers greater opportunities to engage female minority students in increasing STEM efficacy, resilience and perseverance to remain in the STEM pipeline.

The Challenge of Engaging Rural, Minority, Female Students in STEM

In 1970, females made up 7% of the STEM workers in the United States; 1990, females made of 23% of the STEM workers in the United States; 2011, females made up 26% of the STEM workers in the United States (Del Giudice, 2014). The Educate to Innovate initiative focuses on engaging underrepresented groups in STEM, exposing females to STEM fields, setting standards with exceptional role models, and promoting the inclusion of females in tech fields. An example of the importance of greater representation of women in STEM, is to reduce gender biases in research. Research for medications were based primarily on clinical trials focused largely on men, resulting in miscalculated dosages. This awareness only came after women became consumers of the product (Del Giudice, 2014). It is with a sense of urgency that

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we must act to retain young female students in the sciences. Goetz (2007) showed that by around the age of thirteen, an achievement gap appears in most science content areas, and by seventeen, girls achieve at a significantly lower level than boys, particularly in physics.

Providing real-world STEM opportunities, connecting to STEM businesses and industry, and engaging with STEM role models is especially challenging in rural areas. Students in rural areas particularly lack technology and exposure to STEM careers (Wright, 2011). Many rural areas have relied upon business partnerships and STEM alliances to make up for lack of STEM funding, shortages of STEM teachers and access to institutions of higher learning and STEM industry (Hill, 2015).

Belgrave, Cherry, Butler, and Townsend (2008) found that effective mentoring and cultural socialization of minority female students can have a critical impact upon their lives.

Middle school females were selected to be part of a female-focused STEM group, Delta Academy. According to the National Science Foundation (2017), the science and engineering workforce in the United States is made up of 5% Black men, 3% Black women, 2% Hispanic men, and 4% Hispanic women. These groups represent the largest academic achievement gap in math and science. The learner's experience as a science educator in rural public schools led to the discovery of numerous STEM enrichment programs, and if properly implemented and maintained, such programs can reduce the achievement gap in mathematics and science. However, two factors contribute to the lack of minority student participation in STEM enrichment programs. The first factor is that most STEM enrichment programs have a financial cost (i.e. entry fees, materials/supplies, transportation, no substantial monetary compensation for teachers etc.) associated with them. Most economically disadvantaged schools typically do not have funding, staff, parental involvement or resources to support STEM after-school enrichment

programs. There is often no funding available in the school budget to purchase materials for projects or to compensate a teacher's time. Teachers are forced to locate funding to support these programs and projects from outside sources, and in most instances whatever funding is located goes directly to the activity's expenses.

A second factor contributing to the lack of minority student participation is that all STEM enrichment programs require a time commitment from teachers. These same teachers generally lack adequate professional development training and the resources necessary to implement STEM enrichment at their schools. STEM enrichment activities are not written into most schools' curriculum: if a teacher has an interest in doing a project with a group of students, the teacher is typically required to remain after-school to meet with those students. Due to the amount of effort it takes from the teacher to successfully implement a STEM idea, the learner has observed that a large percentage of teachers end up burned out after their second year and disassociate themselves from the project or program.

STEM Identity

Witz (2000) proposes that identity theory allows a better understanding of the difficulties that many students have in participating and sustaining a positive relationship with STEM. Carlone and Johnson (2007) contend, "Cultivating short-term knowledge and interest are not enough to develop sustained interest in science; we need to look beyond achievement and interest to understand how and why some students persist in and others opt out of science." The Carlone and Johnson (2007) model of science identity as an individual who understands the nature of science, can take part in the social and procedural norms of science, and most importantly, one who recognizes himself/herself as a scientist, and is also recognized by others has been adapted for STEM identification in other areas of study (Herrera, Hurtado, Garcia, &

Gasiewski, 2012). The adaptation will be used in this study of rural, middle school girls' STEM identification.

Possible Selves' Theory

To better understand how this participation in Delta Academy will impact the STEM identity of the participants, this study will utilize the conceptual framework of "possible selves'" (Markus & Nurius, 1986). Possible selves' theory firms the consideration of what someone believes that they might become, what they want to become and what they fear becoming. The Markus and Nurius study provides implication that by engaging these participants in self reflections, maintaining a leadership notebook and using technology to create digital stories about their experiences, identity-relevant information and communicated motivations to pursue future goals will be established.

Four main components will be addressed. The first component will be the establishment of relationship-building pedagogies to enhance STEM identity in a rural middle school setting, with an emphasis on the importance of teachers and parents understanding how their identities and their relationships to the students is important in developing and sustaining their interest in STEM. The second component will be the relationship with a community stakeholder to provide during-school and afterschool STEM experiences for female minority students. The third component will be increasing student exposure to STEM opportunities. The fourth component will be connecting the female, minority students to female, minority role models in various STEM careers and connecting them with female high school students at NEAAAT who have been successful in STEM opportunities in and out of school. Students will complete pre-and post-surveys, maintain a journal reflecting upon STEM activities, and complete digital stories reflecting upon their growth and interests in STEM learning.

Self-Efficacy

Self-efficacy is belief in one's ability to perform a specific task (Bandura, 1997). Self-efficacy can determine how well someone achieves at a goal or task because of the confidence they have in themselves. The level of motivation to achieve and successful completion of a goal or task is driven by self-efficacy (Bandura & Locke, 2003). Self-efficacy supports resiliency (Martin & Marsh, 2006). Perseverance is when learners persist to solve a problem or complete a task or goal. Grohman, Ivcevic, Silvia, and Kaufman (2017) call this *grit,* the ability to develop resilience for rigorous learning. If a learner has a strong sense of self-efficacy, they can approach STEM challenges with confidence. The will see learning setbacks as an opportunity to learn and press forward on a new and unfamiliar path instead of viewing the experience as a lesson instead of failure and a signal to retreat from the unfamiliar or uncomfortable (Rickabaugh, 2015).

Female minorities are simultaneously one of the most vulnerable, and one of the most resilient group of students. *Teaching Black Girls* (Evans-Winter, 2011) implements alternative approaches to the study of the intersection of race, class, and gender on schooling, deliberately highlighting how students growing up and attending schools in urban neighborhoods are educationally resilient in the face of adversity. Through dialogue and self-reflection, the author and participants in the ethnographic study reconstruct and tell stories of resilience to derive practice that is both gender and culturally relevant. Fitzpatrick (2012) identified three R's for women in STEM: recruitment, retention and resilience. The same resilience that Evans-Winters says is necessary in the STEM workforce is also necessary for female minority student to persist in STEM classes and extracurricular activities.

Research investigating the persistence of middle school minority females in STEM suggests an assessment system that engages the learner in reflection and multiple technology-

based self-assessment pathways (Chang, 2009). This enables students to become more confident in their learning.

Engagement

The Glossary of Educational Reform (2016) defines student engagement as "the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education." Interest in student engagement has increased. Research has shown that there is a positive correlation between non-cognitive skills (motivation, curiosity, responsibility, determination, perseverance, attitude, resilience, social skills, etc.) and cognitive skills (brain-based skills and knowledge needed to think, learn, problem solve, remember, etc.) (Xie, Fang, & Shauman, 2015). Student engagement can be the key to addressing problems of low achievement, student apathy and high dropout rates (Fredericks, Blumenfeld, Friedel, & Paris, 2004). The level of student engagement can be correlated with a student's sense of belonging. For girls and any other underrepresented group, their sense of ethnic minorities belonging determines whether the student will persist in STEM (Kim, Sinatra, & Seyranian, 2018). If a student does not feel a sense of collegiality and comfort they may start to lose interest, confidence and seek other opportunities. This is especially important in after-school STEM programs that may be a student's first introduction to STEM in an out-of-classroom setting. If the student does not have a sense of belonging, then the student may pursue other extracurricular opportunities. The National Science Foundation states that "Belonging and confidence are not only correlated with each other, but they are also influenced by whom you see in the field, small successes you're able to achieve, and the relevance of what you're learning to impact real-world

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social problems (Dasgupta, 2016)." Schlechty (2002) developed a Continuum of Student Engagement identifying the five levels of student engagement (see Table 1).

Identification with the following behavioral descriptors in Table 2 can give an indication of the level of a student's engagement. The thirty-three item self-report survey, the Student Engagement Instrument (SEI) measures five subtypes of student engagement; teacher student relationships, control and relevance of school work, peer support for learning, future aspirations and goals, and family support for learning. Responses to the survey could determine the types of interventions needed to support student engagement.

The Urgency of Now

The Condition of STEM 2015, reveals that half of the students who took the ACT expressed an interest in STEM majors or occupations (ACT, 2015). This is an increase from the 2013 report that revealed 48.3% expressed an interest in STEM. Although this number reports a high interest in STEM, only 34% of the students had an expressed and measured interest in STEM (ACT, 2015). Achievement levels are high when expressed and measured interests coincide. Only 5% of the African American students met the ACT STEM Benchmark and only 21% of female students met the ACT STEM Benchmark (ACT, 2015). More must be done at an earlier age to nurture students' success in STEM. Having a well-developed science identity includes competence in science, understanding of science, and recognizing oneself as a "science person" (Carlone & Johnson, 2007). This is an interactive process that is complicated and challenging for students who do not have access to teachers, mentors, and peers who look like them or who reflect practices and research relevant to their communities and lives (Tanenbaum, 2014). Even those who demonstrate STEM competence and achievement may struggle to see themselves as potential scientists if they cannot link the work of science to their lives, goals, and

Table 1

Continuum of Engagement

Levels of Engagement	Engagement Typology
Engagement	The student can retain, synthesize and apply what is being presented, resulting in high levels of learning.
Strategic Compliance	The student may learn at high levels, but is only interested in some type of token.
Ritual Compliance	The student learns at low levels and does not retain/transfer learning. They are only interested in avoiding negative consequences.
Retreatism	Student does not participate in the activity and therefore learns little or nothing.
Rebellion	Student is disengaged. He/she actively engages in alternate activities and creates their own goals.

Table 2

Examples of Student Engagement

Levels of Engagement	Engagement Articulation
Authentic Engagement	I really have been engaged in the work and in my classes, and I generally do what I am asked to do because I see the relevance of what I am being asked to do to things that I care about.
Ritual Engagement	I always pay attention in class and do the work I am assigned because I want to get good grades, but I really don't see much merit in what I am asked to do and would not do it if I did not feel I had to.
Passive Engagement	I do what I need to do to get by, but I really don't put out any more effort than I feel I must if I am to stay out of trouble.
Retreatism	I am bored, and I have done very little work for my classes, but I have not caused any trouble for my teachers.
Rebellion	I have been in some trouble because I have not done what the teacher wants me to do, but that is just the way it goes. I don't plan to change what I am doing.

Note. Adapted from Triangle Leadership Academy, Working on the Work Participant's Guide, Student Questionnaire on Classroom Engagement.

perceptions of who does science. This lack of STEM identity contributes to the leak in the STEM pipeline.

Lent, Brown, and Hackett (1994) presented that positive learning experiences and support from family, teachers, peers and role models influence interest in careers. Interventions that include role models as a means of increasing student engagement, interest and perceptions of STEM have been found very effective.

Many families trust that schools are providing their children with the best education that will prepare their students to become productive citizens. Many parents of minority children are not involved in the advocacy of participation in STEM courses and extracurricular activities, where systems disproportionately do not track minority students into advanced STEM courses (Ampaw & Partlo, 2013). The 2015 U.S. News STEM Solutions Conference session "Engaging Parents in their Children's STEM Education" identified the following strategies to engage parents in STEM education:

- Forming partnerships with community nonprofits, civil rights groups, or churches can reach communities of minority students and their families.

- Providing opportunities for parents to learn with their students. Many parents are intimidated by science and mathematics because of their own experiences in school. Let's breaks down barriers and empower the adults with knowledge to assist their students.

- Meet parents and grandparents where they are, you don't have to have an advanced STEM degree to understand and appreciate that STEM is a part of everyone's lives.

- Modeling open-ended questions for parents can transform at-home interactions into inquiry and discovery.

CHAPTER 3: APPROACH TO THE PROBLEM OF PRACTICE

Improvement Science as a Model for Improvement

Three fundamental questions of Improvement Science will be used to guide this study: (1) What are we trying to accomplish? (2) How will we know that a change is an improvement? (3) What changes can we make that will result in improvement? These questions will be addressed from the perspective that fundamental changes that improve systems "(a) alter how work is done, (b) produce visible, positive differences relative to past performance, and (c) have a lasting impact on the organization" (Langley et al., 2009, p. 16).

A Transformational Leader at the Forefront of STEM Implementation

A transformational leader at the forefront of an organization sets a purpose and direction for the school. The vision of the transformational leader "gives the leader and the organization a conceptual map for where the organization is headed" (Northouse, 2013). NEAAAT is on the pathway to becoming a Model STEM School in alignment with the North Carolina Department of Public Instruction's (NCDPI) STEM Attributes. To be successful in this achievement, every student must be on board. It is the success of all and not a few that will achieve this honor. A transformational leader understands the needs of individuals and the group. The transformational leader enables others to lead the group towards success. The process of leaders enabling others to lead will be seen in the engagement of female minority students in this targeted program. Teachers and staff members will empower female minority students to become STEM leaders. In my role as COO and the Executive Director of STEM Education, I am at the forefront of the organizational change in the implementation and alignment to the NCDPI STEM Attributes at NEAAAT. The NCDPI STEM Attributes directly align to the school's goal of a stronger STEM identity and the school's mission of A *World Class STEM Education for All*.

The NCDPI Elementary/Middle and High School Implementation Rubrics are diagnostic tools that can guide STEM schools. "The rubrics aim to articulate a common language for STEM program implementation strategies and to establish a continuum describing good-to-great STEM programs" (Faber, Booth, Parker, Stanhope, & Corn, 2015, p. 14). The elementary/middle school rubric's framework consists of ten attributes of a successful STEM program. These attributes were identified by NCDPI and adopted by the North Carolina State Board of Education in the fall of 2011.

Attribute #6 of the NCDPI NC STEM Attributes states that a model STEM school provides "outreach, support and focus on underserved, especially females, minorities, and economically disadvantaged."

A transformational leader understands that by fostering student resiliency not only are you preparing students for academic achievement, but also preparing them for success in the real world (Sagor, 1996). A transformational leader could use the Improvement Science framework (Langley et al., 2009) to encourage systemic change and support student growth in the process.

This framework has five essential points that help transformative leaders communicate effective innovative practices. First the leader must describe the advantage of the change over previous practices and the status quo. Second, the leader must find ways to align and integrate elements of the change with the current culture and missions of the system. Third, the leader must be able to communicate the change concisely and simply. Fourth, the leader must build in the time and provide support for the change. And finally, a transformative leader must allow others who have some knowledge to review and comment on the change process. Use of Improvement Science allows us to examine the problem of underrepresented participation of minority girls in STEM through a local lens.

Plan-Do-Study-Act Cycle

The study will utilize a three-week Plan-Do-Study-Act (PDSA) cycle, as defined by Langley et al. (2009) for evaluating the program collaboration elements and their effects on student efficacy and engagement. The PDSA cycle is useful for organizing this learning-by-doing study to improve efficacy and engagement. Each cycle begins with clearly communicating the change and recording predictions about what is expected to happen (plan); facilitating the change and documenting what happened (do); comparing the results to the predictions (study); and then deciding on what to do next (act). In many occurrences, a PDSA cycle may not produce the expected results; but this lack of success in the predicted outcomes provides insight as to what to try instead. This point of reflection becomes the start point for the next PDSA cycle. The Carnegie Foundation for the Advancement of Teaching states that educators should be engaged in PDSA cycles to "learn fast, fail fast, and improve quickly" (The Six Core Principles of Improvement, n.d.).

The PDSA cycle will include (1) two hands-on STEM experiences, (2) two collaborative experiences focusing on STEM "soft skills" and (3) an interaction with a female STEM role model. Appendix N is the PDSA model that will be used for this study.

The Gap Between Expressed and Measured STEM Competence

As revealed in the ACT STEM 2015 report, a gap exists between students expressing an interest in STEM and having the ability to academically achieve in STEM subject areas. Utilization of the MISO S-STEM survey, the SEI, the Questionnaire of Classroom Engagement and monitoring academic progress will determine if the actions of focusing on engaging rural, female minority middle school students in STEM is closing the gap between efficacy in STEM and engagement in STEM subjects. Bandura (1997), Gist & Mitchell (1992) and Pajares (2005)

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identified four primary sources of information for self-efficacy beliefs: mastery experience, vicarious experience, social persuasion, and physiological reaction. If we can

1. provide girls with STEM opportunities that allow them to feel confident in working with authentic STEM tools (mastery experiences),

2. establish connections and interactions with STEM role models (vicarious experience),

3. create a peer network where positive feedback and encouragement are fostered (social persuasion), and

4. support the development of a growth mindset where the "fear of failure" is abolished and replaced with a "fail forward" attitude (physiological reaction)

then we can develop STEM self-efficacy that will affect academic performance, confidence and motivation.

The U.S. Department of Labor has developed a curriculum called Soft Skills to Pay the Bills (Dearborn, 2016) they define six soft skills as communication, enthusiasm and attitude, teamwork, networking, problem solving and critical thinking, and professionalism. These are considered STEM soft skills because they can easily be developed in any STEM classroom. Students learn these skills when they collaborate in project-based learning or work together to complete an experiment. What students don't understand is how these skills segue way into the workplace, a job interview, or a student internship.

With anticipated results of more minority females having an expressed and measured interest in STEM, the in-school mentoring program has the possibility to be a model for any organization to follow to increase underrepresented populations' representation in STEM. The school CEO is interested in the study having the impact as a model for community stakeholder

groups to partner with schools in providing mentors, role models and extended learning experiences for students.

Research reviews and meta-analyses find that well-designed, well-implemented social and emotional learning (SEL) programs are associated with positive social, emotional, behavioral, and academic outcomes for children and adolescents (Durlak et al., 2011).

It is the hope that the interactions with the focus group will support

1. STEM efficacy; more positive attitudes towards STEM, confidence in themselves as STEM students, and a greater awareness of careers in STEM.

2. Increased engagement and development of non-cognitive skills necessary for sustainability in STEM courses

Ultimately, it is the learner's hope that these middle grades minority girls will continue pursuit of advanced STEM-related courses and STEM-related extracurricular activities.

CHAPTER 4: IMPLEMENTATION, RESULTS AND RECOMMENDATIONS

Program Design

The program design (see Figure 3) was developed using a theoretical framework that was based on a body of literature on motivation and resiliency for underserved populations in STEM, afterschool programming, and role model education.

I modified a framework developed by Anthony, Alter, and Jenson (2009) to identify risk factors faced by youth when developing a STEM identity. Then I matched corresponding protective factors and affective components that guided the structure of the program, and influenced the type of instructional practices during the intervention

Topics covered during the intervention spanned all areas of STEM (see Figure 4); science, technology, engineering and mathematics. There was a greater emphasis on engineering because although STEMengineering has been part of the educational STEM lexicon for years, engineering has received the least attention (National Research Council, 2010).

The National Assessment of Educational Progress (NAEP) Technology and Engineering Literacy (TEL) assessment was given in 2014, it measured whether students could apply technology and engineering skills to real-life situations. It revealed that girls measured three points higher than boys in problem solving skills, but there was a 28-point difference in proficiency from low-income students and an even greater disparity between racial groups: fifty-six percent of white students met or exceeded proficiency, compared to just eighteen percent for black students. In 2016, women in the United States represented 14.2% of architecture and engineering occupations and numbers were less than 10% for Asian and Black women and Latinas (National Science Foundation, 2017).
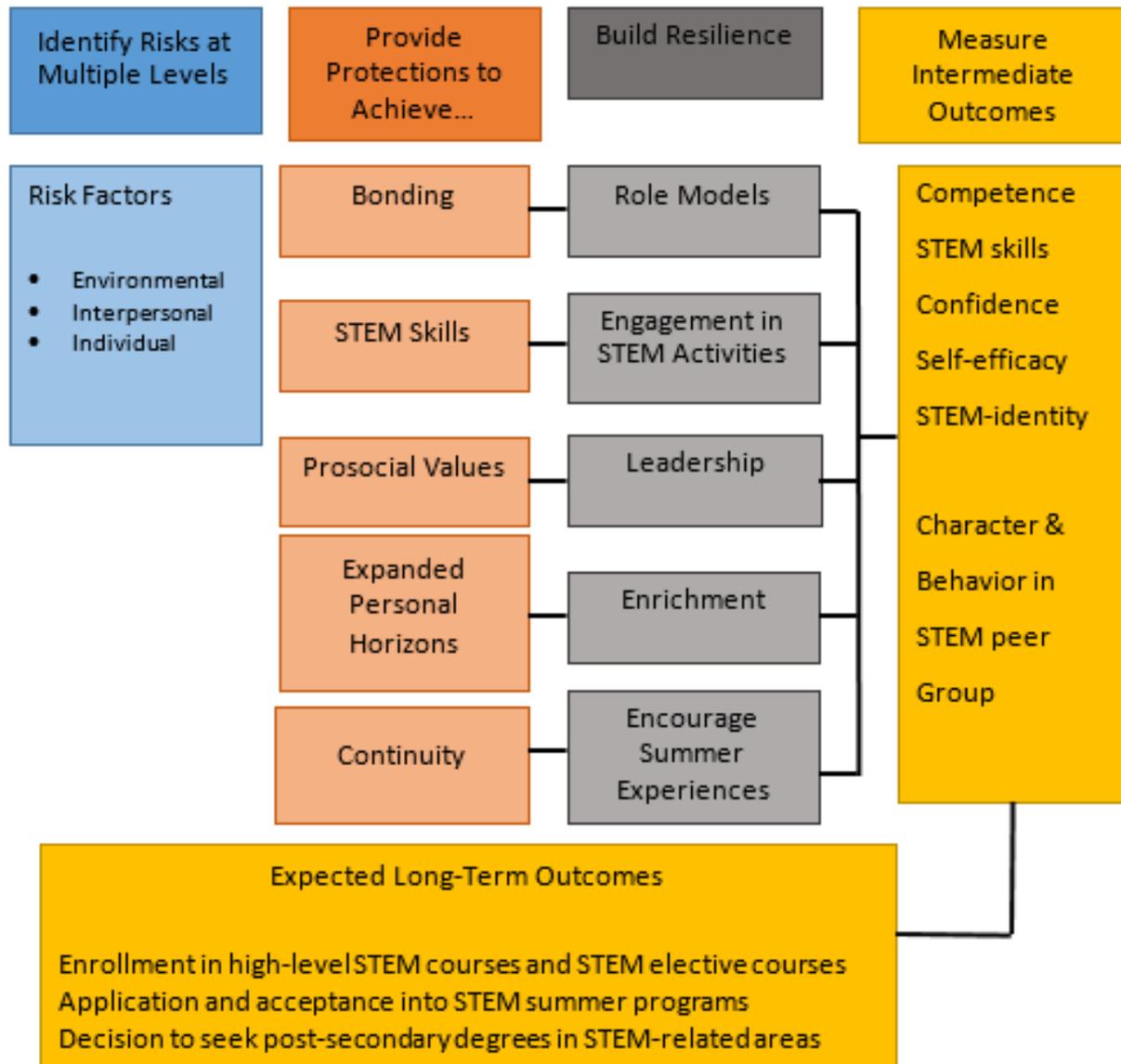
Note. The theoretical framework for the overall implementation of the eight-week Delta Academy intervention.

Figure 3. Theoretical framework.
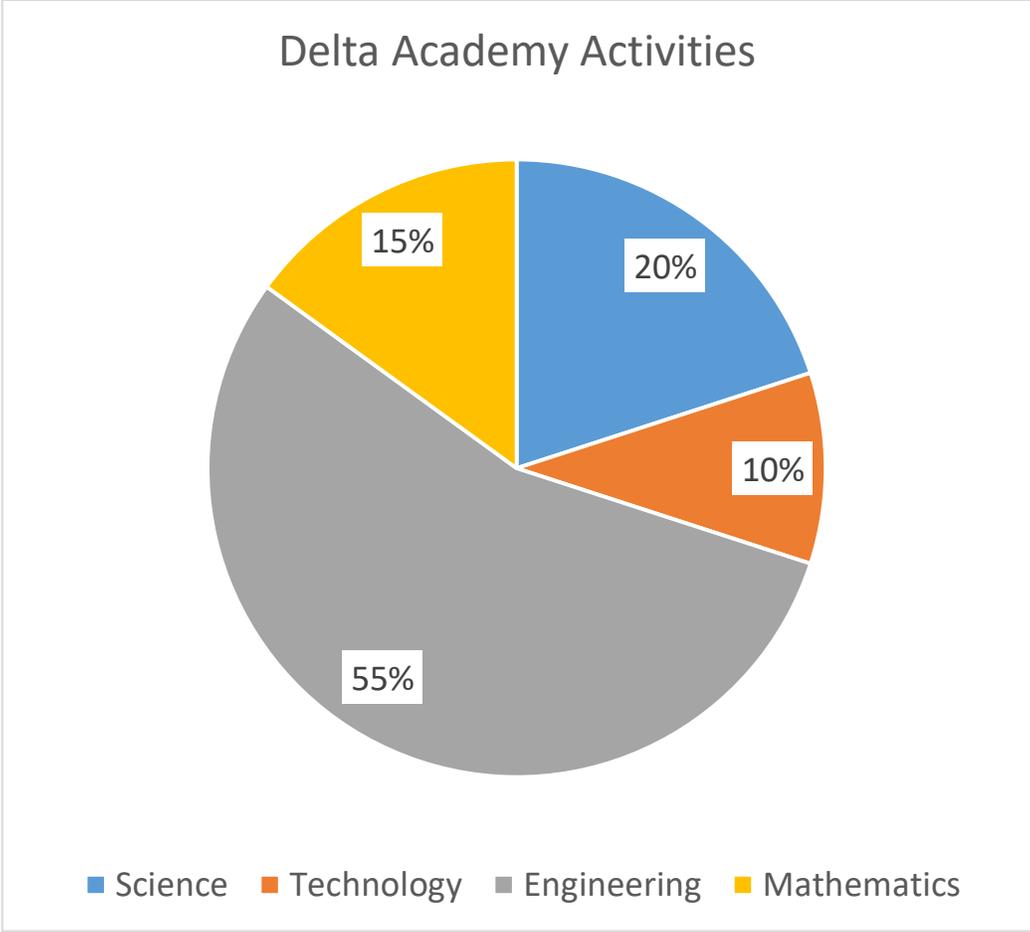
Figure 4. Breakdown of science, technology, engineering and mathematics activities in Delta

Academy.

Program Implementation

Delta Academy is an established after-school club at NEAAAT. The driver diagram (see Figure 5) outlines how community resources and partnerships, teacher buy-in, the school's vision of "A World Class STEM Education for All", and having a student-centered focus have been primary drivers for working towards the success of minority female students in STEM at NEAAAT. Participants attended sessions after school in the seventh-grade science teacher's classroom. There were some Saturday meetings and events, and a luncheon with guest STEM role models. The afterschool sessions were one and a half hours, meeting from 3:00 p.m. – 4:30 p.m. The Saturday events were two to five hours, varying on the activity. I acted as the lead facilitator in the program, the school's technology specialist assisted and volunteers from Delta Sigma Theta Sorority, Incorporated assisted in the intervention. The sample group was comprised of twenty-four participants in the seventh or eighth grade. Assent Participation consent was collected from the participant students during the first intervention session. The MISO S-STEM survey and the Schlechty Student Levels of Engagement Survey Questionnaire were administered during the first intervention session. The after-school club was already meeting on a regular basis (see Appendix B). Participation in the research did not require anything outside of the girls' regular attendance and participation in club activities. Participants attended eight activities and/or events during the program intervention period (see Appendix F).

Theoretical Framework

The theoretical framework for the classroom management and classroom culture of Delta Academy incorporates engagement and efficacy, affective components known as protective factors, and instructional practices used to develop protective factors during instruction (see Table 3). Protective factors are individual traits or environmental resources that minimize the

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Primary Drivers

Secondary Drivers

Outcome

Increase minority female engagement and achievement in STEM (science, technology, engineering and mathematics).

Teacher Buy-In

Trust

Efficacy

Vision

School Improvement

Resources

Community Partnership

Risk-Management

School Structure

Schedule

After School Transportation

Students

Commitment, Rigor, Behavior

Figure 5. Driver diagram for Delta Academy implementation.

Table 3

Theoretical Framework

Risk Factors	Affective Component (protective factors)	Instructional Practices
Environmental		
1. Socioeconomic	Engagement	A. Project-based learning B. Student voice and choice on activities C. Inquiry-based learning D. Online and face-to-face industry tours and engagements with STEM role models.
2. Lack of Opportunity		
Interpersonal		
1. Lack of minority and/or female STEM role models	Belonging	A. Form personal relationships as a peer STEM group with participants. B. Online and face-to-face industry tours and engagements with STEM role models. C. Begin each class with a community circle. D. Establish consistent expectations. E. All students are scientists, technicians, engineers and mathematicians.
2. Not successful in STEM courses		
Individual		
1. Personal Challenges	Self-Efficacy	A. Include multi-model activities B. Correct student behavior one-on-one C. Model appropriate responses to challenges
2. Manage attention levels and energy levels		

Note. Adapted from Anthony et al. 2009. Development of a risk and resiliency based out-of-school time program for children and youth. *Social Work.* 54(1). The theoretical framework for the after-school management and culture of Delta Academy. The framework incorporates risk and resiliency theory, protective factors and the instructional practices used to develop protective factors during instruction.

effect of risk (Jenson & Fraser, 2006). To build a curriculum that can increase student motivation and increase protective factors, I identified factors that prevent students from being successful STEM learners. I adapted a risk and resiliency framework developed for out-of-school programs by Anthony, Alter, and Jenson (2009) to develop a risk and resiliency framework specific to the participants at NEAAAT. Anthony et al.'s (2009) framework defines risk as events, conditions, or experiences that increase the probability, but do not guarantee that a problem will be formed, maintained or intensified. Their framework established three categories of risk: environmental, interpersonal and social, and individual. Using these categories, I identified the risks that were applicable to the participants in my study. For example, an environmental risk for the demographics at NEAAAT is the lack of exposure and opportunity in their communities to STEM industry, businesses and professionals. Instructional practices that can minimize these risks may include utilizing student voice and choice to identify careers that students are interested in learning about and connecting students to role models in their career interest areas.

Research and Development

I began the study by researching the goals and expectations of the partnering organization, Delta Sigma Theta Sorority, Incorporated. According to the sorority's website Delta Academy "was created in 1996 out of an urgent sense that bold action was needed to save our young females (ages 11-14) from the perils of academic failure, low self-esteem, and crippled futures." Delta Academy takes many forms. Some chapters, the Academies are after-school or Saturday programs; others are weekly or biweekly throughout the school year; and still other programs occur monthly. In 2002, Delta Sigma Theta Sorority, Inc. and the Delta Research and Educational Foundation (DREF), in partnership with the American Association for the Advancement of Science (AAAS), and under funding from the National Science Foundation

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(NSF), began the Science and Everyday Experiences (SEE) Initiative. SEE helps involve K-8 students develop effective ways to support STEM learning. NEAAAT partnered with the local Delta Sigma Theta Sorority, Incorporated to provide an opportunity for girls at NEAAAT to grow their STEM identity. The organization was struggling to fulfill this component of their national organization's educational development program. The partnership with NEAAAT provided the targeted demographics of middle grades girls ages 11 – 14 and the skillset I bring as NEAAAT's Executive Director of STEM.

Instructional Practices

I incorporated several instructional practices into the intervention to provide the girls an experience that would protect them against the risk factors (see Table 4) that typically prevent minority female students from participating in STEM. These instructional practices helped frame curriculum, projects and activities, and they worked to build a peer-support group for the female students. I utilized many practices described by Jensen (2013), who researched effective teaching for students of low socioeconomic status. Jensen (2013) describes five actions that can create a positive learning environment. I adapted practices from the five actions to incorporate into my theoretical framework. These practices were: building a positive environment by incorporating student choice into the program, building a climate of support through peer bonding and role models, building cognitive capacity to retool the brain to have a growth mindset, maintaining a flexible schedule to reduce stress, and modeling coping strategies to build perseverance. The instructional practices I used were: project-based learning, utilizing multimodal experiences, and developing personal relationships. The research of Kim et al. (2018) guided the thought that perceptions regarding who is part of the in-group or out-group of STEM fields can be changed through intervention and educational programs. Finally, I used a teaching strategy I found useful

Table 4

Interview Questions

Component Outline #	Question
1	What would you tell other female students they would learn if they participated in Delta Academy?
2	Did you do anything new in Delta Academy that you have never done before? How did you feel about it?
3	What was the hardest part about Delta Academy activities? How did you overcome this challenge?
4	Did you get along with the other female students in Delta Academy? How did you feel about working in groups with other students?
5	Did you feel like a part of Delta Academy? If so, what did the instructors do to make you feel welcome? If not, why?
6	Do you think that what you learned will relate to your life? Can you give an example?
7	What activity was your favorite? Why?
8	Do you spend time outside of Delta Academy with any Delta Academy members?
9	Did you discuss any Delta Academy activities with your family?
10	Had you participated in STEM activities outside of your classes in an out-of-school setting before?

from my twenty-three years as a classroom teacher. This strategy was: all students can imagine, create, and innovate through inquiry based learning when you provide a safe environment to explore.

<center>**Instruments of Measure**</center>

Structured Observations

I followed the impact of protective factors by making observations about two affective constructs: engagement and efficacy. The affective components chosen for the structured observations correspond to protective factors outlined in the risk and resiliency framework developed by Anthony et al. (2009). The protective factors have been selected to reduce specific risk factors identified for students at NEAAAT. The structured observation form had student behaviors that corresponded to positive and negative affective constructs. During the after-school club time I used the structured observation as a quick way to track how many students demonstrated positive or negative behaviors. After each club activity, I summarized the participants' experiences using information from the structured observations.

Interviews

Interviews were used to gain a deeper understanding of participant social and emotional experiences during the intervention. Each interview question was based on an affective component outline in the theoretical framework of the intervention (see Table 4). This interview was designed to measure how participants saw themselves as STEM participants and how they felt during the intervention. The interview data was transcribed and coded to identify patterns and themes that indicate how participants were engaged and gained efficacy during the program.

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Data Collection - Efficacy

Delta Academy participants completed the MISO S-STEM survey at the beginning and at the end of the Delta Academy intervention. The S-STEM survey measures student attitudes toward STEM and interest in STEM careers. The S-STEM Survey contains three constructs measuring attitudes toward STEM content and one measuring attitudes toward 21st century skills, all on a five-point Likert scale (Strongly Disagree to Strongly Agree). The constructs were developed based on a survey for female, middle-school students in an engineering program (Erkut & Marx, 2005). The Upper Elementary (4-5th) and Middle/High School (6-12th) S-STEM Surveys are intended to measure changes in students' confidence and efficacy in STEM subjects, 21st century learning skills, and interest in STEM careers. The surveys are available to help program coordinators make decisions about possible improvements to their program.

Prior to the Delta Academy intervention 10.5% of the Delta Academy girls "Strongly Agreed" that they would consider a career in science. 21.1% of the girls "Agreed" that they would consider a career in science (see Figure 6). The post data revealed an increase to 26.7% of the girls "Strongly Agreeing" to consider a career in science (see Figure 7).

Overall, the girls were confident in their ability to do advanced work in science (52.7%), but post-intervention data revealed an increase (60.0%) after participating in Delta Academy activities.

Prior to the Delta Academy intervention, 52.6% of the Delta Academy girls reported that they know an adult who worked as an engineer (see Figure 8). 100% of the Delta Academy girls met engineers in their Delta Academy intervention experience (see Figure 9). They met twin sisters who worked as an aircraft engineer for The Boeing Company and a biomedical

I would consider a career in science.

- ● Strongly disagree
- ● Disagree
- ● Neutral
- ● Agree
- ● Strongly Agree

21.1%
10.5%
42.1%
15.8%
10.5%
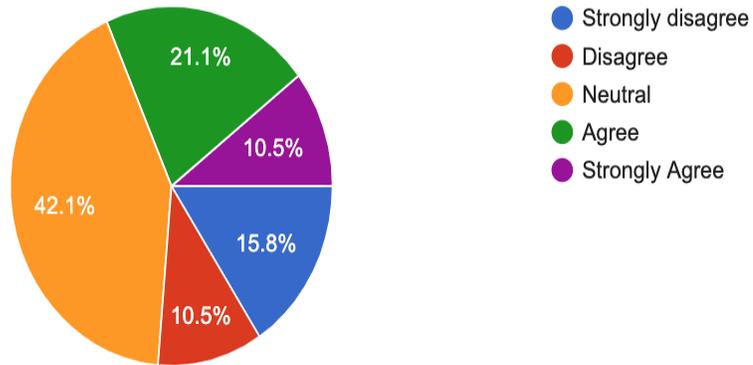
Figure 6. MISO Data Pre – Delta Academy intervention (I would consider a career in science).
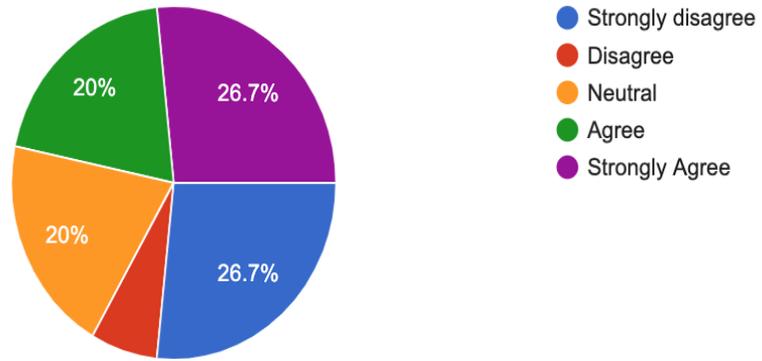
Figure 7. MISO Data Post - Delta Academy intervention (I would consider a career in science).
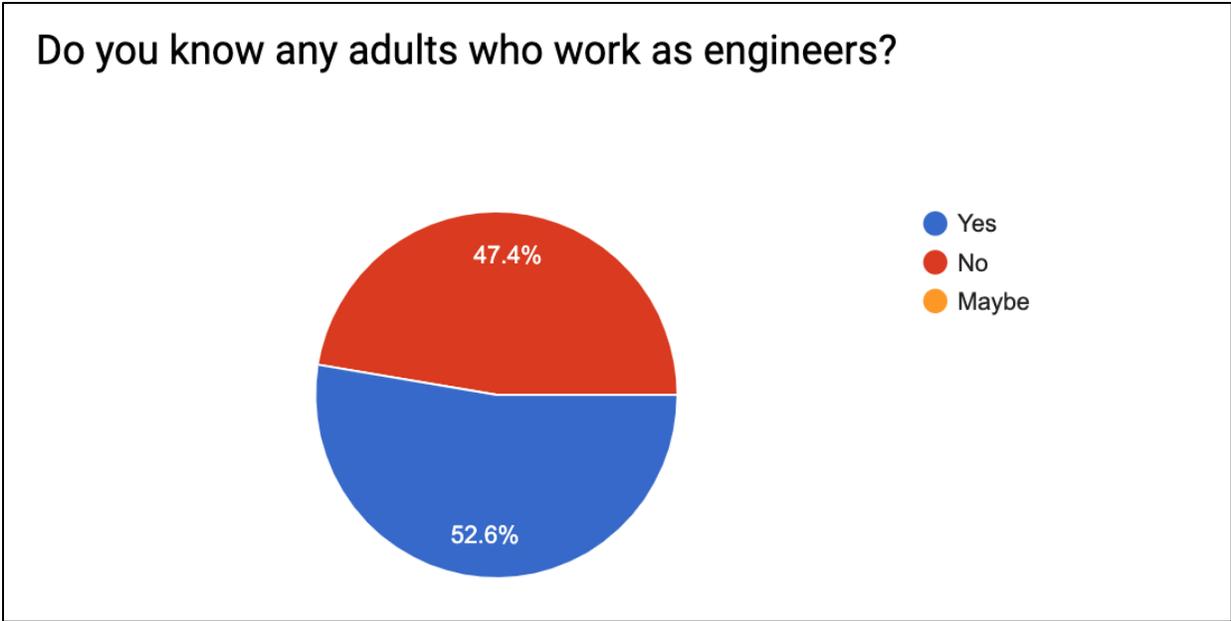
Figure 8. MISO Data Pre - Delta Academy intervention (Do you know any adults who work as engineers)?
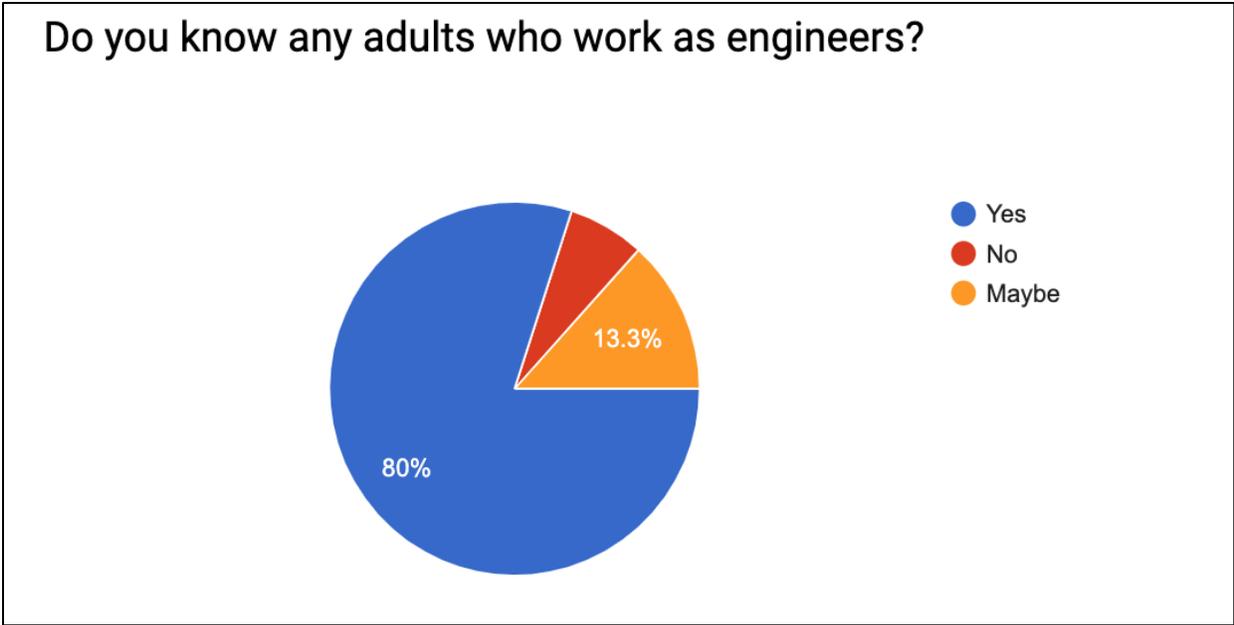
Figure 9. MISO Data Post - Delta Academy intervention (Do you know any adults who work as

engineers)?

engineer. They met a theme park design engineer virtually through an online cloud-based platform. There was an increase to 80% of the girls identifying that they knew an adult who worked as an engineer. When I asked the girls why this question did not receive a 100% reporting, some of the girls stated that they met these role models, but they did not know them. I find this to be a significant data finding because when introducing STEM role models, the quality and depth of the interaction and the length of time of the role-model interaction determines the impact upon some girl's perception of relatedness to themselves. One student remarked that the female biomedical engineer was "down to Earth" and "very real". Another student said that the female engineers reminded her of women in her family, "they were very determined." Being able to identify with women in STEM is important, because it helps underrepresented girls imagine themselves as STEM professionals. Lee (2011) found that communities want to interact with STEM professionals they can relate to. Being able to relate to a STEM role model makes the goal of succeeding in a STEM career attainable. "She grew up on a farm, I live in the country with ducks, chickens and goats. If she can do it, so can I," said Mikiah, a Delta Academy girl after meeting an African American female aircraft engineer.

Self-Efficacy

Participants in the program showed positive self-efficacy during the program. During the interviews, students described positive perceptions of self-efficacy during the program. Most participants reported being successful in the program, overcoming challenges, and enjoying new experiences. Some participants who showed high self-efficacy during the program were observed to have low self-efficacy related to school performance (see Table 5). For example, a student who reported high self-efficacy in Delta Academy acknowledged that she did not perform well academically because she did not have a good relationship with the teacher. The lack of a

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Table 5

Self-Efficacy Data

Question	Answer Category	Number of Students	%
Do you feel you were successful in Delta Academy?	Yes	22	96%
	No	1	4%
Goal Orientation	Mastery Goal	23	100%
	Performance Goal	21	91%
Did you do anything new in Delta Academy that you had never done before?	Yes	23	100%
	No	0	0%
What type of activity would you like to do in the future? (Students could choose two)	Field trip	19	82%
	Lab activity	16	70%
	Debates about STEM issues	7	30%
	Guest speakers in person	5	22%

positive relationship with the teacher, led her to feel apathetic about her work in the classroom. Some participants who showed high self-efficacy during the program were taking on STEM challenges beyond the club. The MISO Pre-Delta Academy intervention survey revealed that 52.7% of the girls agreed with the statement, "I am sure I can do advanced work in science" (see Figure 10). The MISO Post-Delta Academy intervention survey revealed an increase of 60% of the girls agreeing with their ability to do advanced work in science (see Figure 11). There was an increase from 21.1% to 33.3% of the girls stating that they strongly agree that "I am sure I can do advanced work in science" (see Figure 11).

When asked about their success in the program, twenty-two out of twenty-three students indicated they felt they were successful. When participants described why they felt successful, the responses fell into one of two goal orientations: mastery goals or performance goals. Mastery goals are goals that are dedicated towards intrinsic learning. Performance goals are goals that seek to complete a task to appear to be competent. For example, a student described her success in terms of a performance goal by saying, "I have confidence that I can be a team leader and spokesperson because I had many opportunities to lead a research team and present our findings to different groups of people." Another student fit within the mastery goal category by describing her success as "I know how to program EV3 robots and can show others, I would like to volunteer for the Summer Bridge camp to teach new students about EV3 programming." Twenty-three students (100%) cited achieving mastery goals, and twenty-one students (91%) cited performance goals.

Data Collection – Engagement

The Schlechty Student Levels of Engagement Survey Questionnaire was administered to the girls to evaluate their level of engagement during the Delta Academy intervention (see Table

I am sure I can do advanced work in science.

●	Strongly disagree
●	Disagree
●	Neutral
●	Agree
●	Strongly agree
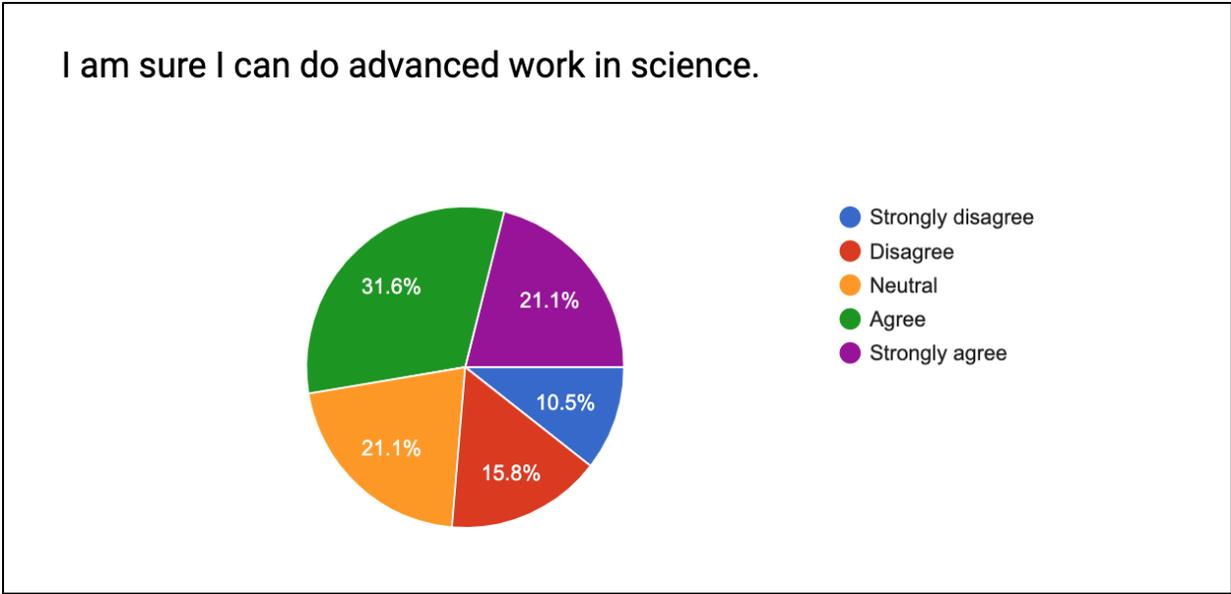
Figure 10. MISO Data Pre - Delta Academy intervention (I am sure I can do advanced work in science).
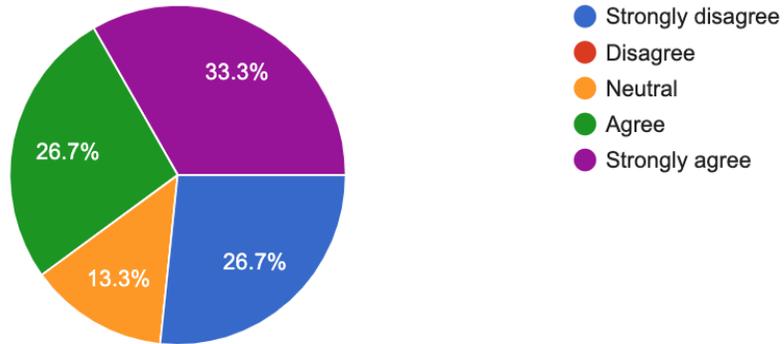
Figure 11. MISO Data Post - Delta Academy Intervention (I am sure I can do advanced work in science).

7). Engagement is not just keeping busy. When educators use authentic tools of learning and tackle real-world problems students become self-motivated and real engagement in learning takes place (Wasserstein, 1995). Self-motivation comes from a desire to learn something new, to enjoy learning for the sake of gaining knowledge and achieving personal goals rather than for a reward or incentive. This mindset of intrinsic motivational goals for learning lends itself to students who are highly engaged and highly motivated to achieve. Delta Academy takes the advice of Schlechty (2002) to provide novelty and variety as a way of highly engaging students. I worked hard to create fun learning experiences that "hooked" students into wanting to explore, learn and realize that STEM sparks natural curiosities.

It was the goal to design activities that would align to "Engagement Indicators" identified by Schlechty (2011),

- The student is attentive to the task because he or she finds personal meaning and value in the task; the student sees the task as responding to motives and values he or she brings to the work.

- The student persists with the task even when he or she has trouble and does not compromise personal standards for completion of the task even though he or she might be able to negotiate a lower standard if he or she wanted to.

- The student volunteers resources under his or her control – time, effort, and attention – which is to say that the student is committed to the work and places moral value on its completion.

Delta Academy students enjoyed different parts of the program and were highly engaged in the activities. On the Schlechty levels of engagement (see Appendix G) the Delta Academy girls had high attention and high commitment when participating in all the activities. The girls

reported that they believed that the activities had meaning and were connected to their STEM

growth and identity. The girls persisted in the face of difficulty and worked together to problem

solve and achieve goals.

> Some of the design challenges we did were very difficult, but taught us a lot.
> You just didn't settle on one design, you had to think beyond your original design when
> you thought you were done. It was hard, but it was fun. – Samoya, Delta Academy
> Member

I made observations of participant affective responses during and after each club meeting

using the Structured Affective Observation forms. After each meeting, club advisors and I

discussed observations from the day, and I recorded unstructured observation observations in a

journal.

All the participants were interviewed during the 8th week of the program observation. A

total of twenty-three participants were interviewed. The semi-structured interviews were

designed to gather data about motivation (self-efficacy, belonging, and engagement) of the

participants. Each interview took approximately fifteen minutes. The interviews were

administered during club time in the same classroom where activities took place. I asked each

participant to take a break in the club activities to answer the survey questions at a nearby table

with me.

The results of the Student Engagement Instrument Responses revealed that the

participating girls feel supported by their families in school (see Table 6) and in the Delta

Academy program (see Table 7). Many schools find that the lack of parental support is

counteractive to enabling intrinsic motivation in students. In the case of these girls, parent

support is present and the girls feel like their parents support them in school and in the Delta

Academy after-school program. This is an opportunity to utilize parent involvement in the

development of STEM identities in girls. Parents can support their daughters in STEM by

Table 6

Student Engagement Instrument Responses for School Setting

Item	Strongly Disagree	Disagree	Agree	Strongly Agree
My family/guardian(s) are there for me when I need them.	0%	0%	30%	70%
After finishing my homework, I check it over to see if it's correct.	0%	10%	80%	10%
My teachers are there for me when I need them.	0%	0%	70%	30%
My education will create many future opportunities for me.	0%	0%	40%	60%
Most teachers at my school are interested in me as a person, not just a student.	0%	20%	40%	40%
Students here respect what I have to say.	10%	20%	40%	30%
I'll learn, but only if the teacher gives me a reward.	80%	20%	0%	0%
School is important for achieving my future goals.	0%	0%	30%	70%
Overall, adults at my school treat students fairly.	0%	10%	70%	20%
I feel safe at school.	0%	10%	60%	30%
I feel like I have a say about what happens to me at school.	0%	0%	40%	60%
I'll learn, but only if my family/guardians give me a reward.	100%	0%	0%	0%
What I'm learning in my classes will be important in my future.	0%	10%	40%	50%
Learning is fun because I get better at something.	0%	20%	50%	30%

Table 7

Student Engagement Instrument Responses for Delta Academy Setting

Item	Strongly Disagree	Disagree	Agree	Strongly Agree
My family/guardian(s) are there for me when I need them.	0%	0%	30%	70%
After finishing my homework, I check it over to see if it's correct.	0%	10%	10%	90%
My Delta Academy mentors are there for me when I need them.	0%	0%	0%	100%
My education will create many future opportunities for me.	0%	0%	30%	70%
Delta Academy mentors are interested in me as a person, not just a student.	0%	0%	0%	100%
Students here respect what I have to say.	0%	0%	10%	90%
I'll learn, but only if the teacher gives me a reward.	100%	0%	0%	0%
Overall, adults in Delta Academy treat students fairly.	0%	0%	20%	80%
I feel safe at Delta Academy.	0%	0%	0%	100%
I feel like I have a say about what happens to me at Delta Academy.	0%	0%	0%	100%
I'll learn, but only if my family/guardians give me a reward.	100%	0%	0%	0%
What I'm learning in Delta Academy will be important in my future.	0%	0%	30%	70%
Learning in Delta Academy is fun because I get better at something.	0%	10%	20%	70%

1. Holding high expectations for their daughters in STEM subjects and extracurricular activities.

2. Helping to build positive attitudes and beliefs toward STEM, by avoiding negative messages and stereotypes and supporting pro-STEM values and interests.

3. Providing STEM materials and opportunities. For example, LEGO sets and LEGO robotics that promote interests in building can be the first steps toward engineering.

4. Challenging students to solve day-to-day problems by researching for information; such as researching information on the Internet, planning family vacations (logistics), determining how to reduce household waste or decrease cost of use of utilities.

There was a difference in how the girls felt that what they said was respected by their peers in school versus Delta Academy. In the smaller peer group of Delta Academy, students felt like what they said was more respected (see Table 7). Relationships matter to students and can increase their sense of belonging and affiliation. It is recommended that the school think strategically about enhancing a sense of belonging by creating peer networks such as Delta Academy to support the retention and success of girls in STEM. In the classroom, students can practice listening skills, dialogue and professionalism to show respect to each other.

There was a greater perception that what the students were learning in Delta Academy will be important in their future in comparison to what they were learning in school. Of course, students are learning life-long skills in their regular classroom, but the Delta Academy program may have seen a higher reported level of engagement (see Table 7) because the girls found the subject areas in Delta Academy to have more personal meaning and value, therefore there is a higher level of commitment to the tasks. It was proven that students persevered with tasks, even when they found them to be difficult because they saw the value in working through a problem.

It is not often the knowledge or the product, but the journey of learning, the process of learning that is the most rewarding.

Learning is fun because I get better at something. In the school setting, only 30% of the girls reported that learning was fun because they got better at something (see Table 6). In the Delta Academy setting, 70% of the girls reported that learning was fun because they got better at something (see Table 7). In Delta Academy, a safe environment was constructed allowing students to "fail forward". The "fail forward" culture was supported by positive and encouraging peer interactions, cycles of improvement, and opportunities to practice the same professional skills continuously. Many times, curriculum goals are driven by pacing guides that must speed through a set number of standards and objectives. Allowing time for a cyclic approach reinforces skills and builds efficacy.

One hundred percent of the girls felt like they had a say about what happens to them in Delta Academy (see Table 7), but only 60% felt like they had a say about what happens to them in their school work (see Table 6). During Delta Academy, I took time to get input from participants about how they wanted to learn during activities. Schlechty (2011) connect giving students choices during lessons promotes intrinsic motivation. I think that allowing students to be responsible for their own learning invites them to invest more effort and attention towards their work. This increases the levels of engagement.

Belonging. Schlechty (2011) states that students are often more motivated to work when they do so in the presence of and in cooperation with others (see Table 8). Students, like adults, are social beings, and they value group effort. Schlechty refers to this as" affiliation". In this research, I refer to this sense of group identity as "belonging". The students were asked if they felt like they belonged at Delta Academy. All the students felt they belonged. These students'

Table 8

Belonging

Question	Answer Category	Number of students (out of 23)	%
Did you feel like you belonged at Delta Academy?	Yes	23	100%
	Positive peer relationships	18	78%
	Positive teacher-student relationships	21	91%
	Content aligns to interest	14	61%
	Exposure to role models	20	87%
How did what you learned in Delta Academy relate to your life outside of school?	Problem-solving skills	20	87%
	Persistence in learning more about females in STEM fields	23	100%
	Did not talk about what we did in Delta Academy at home	0	0%

Note. Student interview data from the Motivation category of relatedness and belonging.

reasons for feeling a sense of belonging included: having positive peer relationships, positive teacher relationships, content aligned with their interests and exposure to STEM role models and careers that they were interested in. To dig deeper into why the students had a sense of belonging, the participants were asked to describe what helped them feel belonging in the interviews. The students identified four factors that helped them feel a sense of belonging: having positive peer relationships (78%), having positive student-teacher relationships (91%), having interests that aligned to the Delta Academy activities (61%), and having exposure to role models (87%).

Structured Observations

Table 9 includes the results of structured observations, revealing that participants demonstrated both positive and negative behaviors corresponding with motivation constructs. Participants were most often eager to share and demonstrate their learning (22 observed behaviors) and share their life events and stories (12 observed behaviors) which are indicators of a sense of belonging and positive engagement. The most frequent negative behavior was students who were worried about their grades. This is an indicator of negative self-efficacy.

<div align="center">

Outcomes

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Ahyma – A Conversation about Efficacy and Engagement

Below I describe the experience of a participant in Delta Academy. This participant showed vulnerabilities in areas that would have been risk factors to underrepresented females in STEM, self-efficacy and engagement.

Ahmya's profile demonstrates how being in a classroom that does not lend itself to high attention and high commitment can lead to a high-achieving student succumbing to strategic compliance. In strategic compliance, a student will exhibit high attention because there is an

Table 9

Structured Observations

Affective Construct for Motivation	Positive /Negative	Frequency of Behavior Observed
Self-Efficacy		
Student volunteers to show their project in class	(+)	8
Student is eager to volunteer to answer	(+)	6
Student is eager to demonstrate learning to	(+)	8
Student comments they can't do something	(-)	1
Student expresses worry about their grades	(-)	3
Student does not participate in activity	(-)	1
Engagement		
Student shows effort during activities	(+)	9
Student shares life events and stories	(+)	6
Student volunteers to show the work the group	(+)	8
Student is off task	(-)	2
Student ask to do something else	(-)	0
Belonging		
Student shares life events and stories	(+)	6
Student participates in group activities	(+)	9
Student takes time to talk to instructor one on one	(+)	7
Student doesn't talk to others during class	(-)	1

Note. This table shows the frequency of behaviors associated with motivational components over the course of seven classes during the intervention. A behavior is denoted as being a positive demonstration of a component with a (+) symbol. A behavior is negative if denoted with a (-).

intrinsic value to attain good grades, but low commitment because extrinsic goals are not obtained through mediocre applications. This can become a slippery slope for students to fall into the level of the Schlechty Continuum, known as retreatism. In retreatism, students have a low level of attention and a low level of commitment. Ahmya had become bored in most of her middle grades classes, but she did find challenge in the accelerated high school math class that she was taking. There was a scheduling difference between the middle grades and high school classes, giving Ahmya a 40-minute gap between class changes in which she remained in a middle grades classroom. She had begun to spend more time being a distraction during these 30 minutes, after completing her work. She would complete her work and then spend time on her phone or talking to classmates, which often led to classroom discipline by the teacher. Through Delta Academy, Ahmya was challenged to participate in a research project that would extend her classroom learning. She could research an area of interest that led to her becoming a part of the school's middle grades FIRST LEGO League ® research team. Ahmya researched how plants could be transformed genetically to better withstand growth in space. Her research in plant engineering became a key component of the team's research presentation. To add technology to the team's presentation, Ahmya created a video featuring an avatar of herself as an astronaut plant specialist describing the process of genetic plant transformation. The video began with Ahmya's avatar saying "Hello, I am research specialist Ahmya…" This is an affirmation of her belief that she can see herself as a plant geneticist. The team went on to win the first-place research award at the state-level of competition. The Delta Academy advisors connected Ahmya to a female plant geneticist at the local university. The geneticist challenged Ahmya to further her studies and connect what she had proposed with actual bioengineering research to validate her hypotheses. Ahmya continued and found the current research of plant geneticists. Because of

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her persistence and willingness to persevere the university plant geneticist has invited Ahmya and the FIRST LEGO League ® research team to work in the laboratory to undertake plant genetic transformations. So, because of engaging Ahmya in work that was meaningful to her interests and connecting her to a STEM role model Ahmya's alternative reality avatar plant geneticist is now her reality. Ahmya will have the opportunity to work with authentic tools of plant genetics and with a female role model plant geneticist.

Ahmya's explanation of getting in trouble in class because she was bored sheds light on how the traditional classroom may not differentiate learning to engage all students. Ahmya is very intelligent and must be challenged to go beyond mediocrity. If students are not allowed to grow beyond the expected and given the opportunity to use their voice and choice to engage in their learning, the educational community is missing the opportunity to grow potential STEM leaders. If the expectation in the classroom is to do silent, independent work, her behavior of talking with others may be disruptive and disrespectful. She was at risk of devaluing her learning strengths and maligning her self-efficacy.

Ahmya contrasted her experience in Delta Academy to her experience in school by saying "We are doing STEM, not just looking at videos on our computers or talking about it." She describes her experience in Delta Academy and subsequently membership on the FIRST LEGO League ® (FLL) team as "learning to work with different people and making new friends." She described the Delta Academy leaders as "they push you hard to go beyond your best and never give up, they always say there is room for growth." Ahmya applied the concept of seeking opportunities for growth in her classes. Instead of being on her phone or talking, she began to utilize time after completing her assignments to extend her research work.

The multi-modal, hands-on learning in Delta Academy lent itself to various types of learning styles – verbal, written, technological, collaborative, etc. When Ahmya participated in the varied modes of learning – some of which were strengths and some were weaknesses, it helped her build her self-efficacy toward being successful outside of Delta Academy. Ahmya had a chance to demonstrate success in a supportive and protective environment that led to opportunities beyond the program. Delta Academy fostered a commitment to research, promoted collaboration and teamwork, supported exploration to act upon the research and provided connections to female STEM role models.

Why You Need Intentional Focus to Reach Your Goals

The establishment of a peer group focused upon building efficacy and increasing engagement for girls provided an opportunity to nurture potential and growth in STEM. It is a simple solution for schools. If you look at your school data and see that a demographic is struggling to succeed, the question you need to ask is: What are the supports that you put in place to develop capacity within the identified group? The practices put into place for Delta Academy students were the formation of a small peer-empowering group, role models to strengthen STEM identity, opportunity to engage in quality, authentic learning at a high level of engagement, and an opportunity to practice and demonstrate STEM learning. These are practices that can be used for any identified group.

Delta Academy girls were encouraged and provided opportunities to extend their STEM learning beyond the after-school program into other extracurricular programs. Three of the girls (including Ahmya) became members of the middle grades FLL robotics team. The three girls worked together, along with three white male students and two white female students, on developing the research project for the team. The three Delta Academy girls were key innovators

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and communicators on the research team. They were prominent and very engaging in the presentation of the research. The results of their well-documented and engaging biotechnology research project led to the FLL team winning the 2019 North Carolina State Research Award. The girls decided to videotape a three-minute segment of their five-minute presentation and submit it to the Biogen SPARK Video Contest. Three of the four girls featured in the video were members of Delta Academy. The contest was open to students in middle schools and high schools across North Carolina and Massachusetts. The video submitted by the Delta Academy girls was one of six middle school videos selected from North Carolina to compete in a thirty-one day online public voting competition. After the thirty-one days, the video with the most online voting submission would win $10,000 for their school. It was the focus of the girls for the award money to go to the high school robotics program, of which they would be a part of the next school year. The Delta Academy girls' video was the Grand Prize Winner, winning $10,000 for NEAAAT's high school robotics program (see Appendix H). Having engaged in peer team-building activities and project-based learning in Delta Academy these girls had formed their own network of sister-empowerment in STEM.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSION

The data collected in this study contributes to the research questions:

1. Can a STEM-focused peer group, at NEAAAT, increase self-efficacy perceptions about middle grades female minority students' success in STEM?

2. Can a STEM-focused peer group empower NEAAAT middle grades female minority students to become more engaged in STEM activities by developing the non-cognitive skills necessary for sustainability in STEM; such as creativity, teamwork, perseverance, resilience and motivation to learn?

The instructional practices outlined in the theoretical framework of the intervention provide practical ways for teachers to support students' social and emotional learning. The results collected in this study support that these instructional practices are effective ways to develop a holistically supportive program. Chapter 5 provides educational leaders with the next steps, along with a suggested professional development planning tool that can be utilized in selecting STEM solution ideas for their school. The tool was specifically designed and developed to help educational leaders determine their teacher's knowledge level of potential STEM solution ideas, identify potential partners/mentors/role models and identify local resources. Information gathered through this tool has the potential to help leaders develop a professional development plan aligned to the local STEM needs and needs of identified underserved groups within a school district. For any school attempting to promote community partnerships, provide STEM role models and provide protections against the threats that prevent underserved and underrepresented populations from succeeding in STEM, I offer a driver diagram (see Appendix J) that will allow school leaders to connect solutions to overcome existing threats against desired STEM goals. The driver diagram (see Appendix J) and use of a PDSA document (see Appendix

K) can be utilized to direct implementation of a similar program with any demographic for STEM implementation.

Efficacy

This study revealed the role that efficacy plays in the confidence of middle school girls in relation to their confidence in math and science. The connection between efficacy and career development in adolescents is well documented (Hackett, Betz, Casas, & Rocha-Singh, 1992; Pajares & Miller, 1994). According to Bandura and Wood (1997), it is important to teach skills related to specific interventions such as:

- Goal-setting

- Planning

- Self-regulatory process

- Academic motivation

Dweck (2007) provides evidence that it is important to have a growth mindset rather than a fixed mindset to improve self-efficacy and academic performance. This growth mindset is important for middle school girls to protect them from the threats of cultural stereotyping (Dweck, 2007).

Students with strong self-efficacy are willing to challenge themselves with difficult tasks and be intrinsically motivated. Students with strong self-efficacy will seek STEM experiences beyond their classroom experiences.

Delta Academy girls have demonstrated that they are willing to work hard to grow their skillsets and stretch beyond their comfort zones. Twenty-two percent of the girls were members of the school's middle grades robotics competition teams. Because of their engineering experiences in Delta Academy, it is anticipated that 43% of the girls will be a part of the middle grades robotics competition teams.

It is evident that the efficacy and high level of engagement in STEM will continue beyond the protective practices of Delta Academy. Six of the twenty-three girls will be part of the high school robotics team next year. One hundred percent of Delta Academy girls have applied to summer STEM camps; including robotics camps, health careers camp, a minority-focused camp at the North Carolina School for Science and Mathematics, 4-H Summer Camps, U.S. Naval Academy STEM Summer STEM Program, veterinarian camp, aviation camp, and drone camp. One of the girls will be attending a summer leadership experience at Yale University.

The Delta Academy girls will serve as STEM ambassadors at NEAAAT's Summer Bridge. Summer Bridge is a one-week summer camp to introduce new students to NEAAAT. Newly enrolled students are introduced to project-based learning, the engineering design cycle, the NEAAAT digital world of one-to-one technology, the "NEAAAT Way", school procedures, and complete placement tests for the upcoming school year.

One hundred percent of the Delta Academy members will have an extracurricular STEM summer experience.

In one of the culminating activities, all girls watched a short video about the #ILookLikeAnEngineer campaign and were challenged to work in small groups to create their own #ILookLikeASTEMStudent video. There were instructions and a rubric (see Appendix L) to evaluate the videos, placing an emphasis on videos that communicated the girls' perspective on the state of women in STEM. The videos reflected the girls' confidence in their ability to advance in STEM courses and eventually the STEM workplace. The videos also demonstrated their awareness of current landscape of women in STEM.

Engagement

The federal legislative agenda from the Girl Scouts of the USA (Generation STEM, 2012) provides solutions to the retention of girls in the STEM pipeline:

- Engage and motivate girls.

- Provide girls with mentors and role models.

- Support hands-on activities and inquiry-based learning.

- Build relationships with business and industry to expand opportunities for girls.

Delta Academy provided opportunities in all the Girl Scouts of the USA (2012) suggested solutions providing multiple evidences that these practices can lead to the retention of girls in the STEM pipeline.

Engage and Motivate

Engaging curriculum was designed purposefully guided by Anthony et al.'s (2009) risk and resiliency theory and Phillip Schlechty's *Working on the Work Framework*:

1. Students are customers, volunteers, and knowledge workers. What they have to volunteer is their time and commitment.

2. The primary work of teachers is to design engaging work for students and guiding them in the sources of instruction they need to do the work successfully.

3. Differences in the level and type of engagement directly affect the effort that students expend on school-related tasks,

4. Effort affects learning outcomes at least as much as it does intellectual ability.

5. The level and type of engagement vary depending on the qualities teachers build into the work they provide students.

6. Therefore, teachers can directly affect student learning through the invention of work that is most engaging to students.

Provide Mentors and Role Models

The Delta Academy girls could interact with role models on many different levels. A female biomedical engineer and aircraft engineer, now state Senator, were the guest speakers at the Women's History Month Tea hosted by the group. An internationally renowned adolescent physician and psychologist, who was native to one of the counties represented by the girls' regional public charter school, skyped with the group on World AIDS Day to share her research about sexually transmitted diseases and adolescents. In both role model experiences the Delta Academy girls remarked how they were impressed that someone from their rural region of northeastern North Carolina had achieved prominent success in their STEM professions. These women are STEM role models and role models of local identity in STEM. The Delta Academy girls interacted with the school's high school robotics team female members. #FIRSTLikeAGirl is a national FIRST LEGO League social media movement to encourage girls in STEM. The #FIRSTLikeAGirl website states (FIRSTLikeAGirl, 2018)

> Through this social media campaign, we empower girls with the confidence to overcome cultural pressures, follow their dreams in STEM, and become active members of the FIRST community.

The women of the sponsoring sorority also served as role models, although there were very few who were STEM professionals. The affiliation with a group of professional women who were all college graduates was impactful. After the Women's History Month Tea, one of the Delta Academy girls stated that she had reconsidered applying to Historically Black Colleges and Universities (HBCUs) because of the grace, sisterhood and professionalism shown by the women at the tea.

I genuinely believe that you cannot be what you cannot see. Whether it is through a face-to-face or virtual online platform, girls are more empowered to identify with STEM role models when they have a chance to interact with female STEM role models.

Support Hands-On Activities and Inquiry-Based Learning

Every month the Delta Academy girls participated in hands-on, inquiry-based activities. These activities included science, technology. Engineering and mathematics; with a greater frequency of engineering activities. The girls used authentic tools of STEM. When learning about the effects of drugs (caffeine and sugar) on the nervous system and muscle system of freshwater flatworms the girls wore lab coats, goggles and gloves as they worked with the flatworms in scientific petri dishes and pipettes. While conducting the experiment (which intersected biology, chemistry and technology) they also learned the mathematics of calculating concentrations of solutions. The results of these experiments enabled the Delta Academy girls to make data-driven decisions about how caffeine and sugar can affect behavior and related the behavior of the flatworms to human drug addiction.

Hailee captured how engaging in hands-on activities lends itself to the continuing work of developing efficacy and participating in higher levels of engagements beyond Delta Academy in the following statement:

> My FLL experience was an adventure. I started off as a part of the research team and from there ended up becoming a member of the robotics team. When I first started off as a member of the robotics team I was confused about what they wanted me to do. I wasn't good with building the robots because I had never built something that had to move. But they wanted me as a part of something different, the programming team! When we started programming in my robotics class I caught on quick and found that it was something I was good at and that I enjoyed! From FLL I gathered valuable life skills that I didn't have before I started school. Being on the FLL team taught me to work with others even if I don't like them. It taught me the value of my teammates and how important friendships are. And how when something goes wrong two is better than one and that those friendships and bonds that you have made help you along the way. FLL isn't easy. You're gonna have to work with people you don't like. But you have to learn

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to work together as a team despite your differences. And that's what I learned as a part of the FLL team.

Build Relationships with Business and Industry

Delta Academy girls produced a video for the 2019 Biogen SPARK Video Contest. Biogen is a global biotechnology company based in Cambridge, Massachusetts and Research Triangle Park, North Carolina. The Biogen Foundation Spark Video Contest made an open call to Massachusetts and North Carolina middle and high schools to submit a video on the topic "Biotechnology in Your Life". Students were encouraged to be as creative as possible, while remaining accurate to the science. The Grand Prize-winning videos were chosen through public and Biogen employee voting rounds. Eight (8) Grand Prize Winners received ten thousand ($10,000 USD), awarded in a check payable to the school and three (3) GoPro HERO5 Session video cameras. The Northeast Academy for Aerospace and Advanced Technologies was among the two Grand Prize Winners for North Carolina Middle Schools. NEAAAT's video, "Biotechnology May Change Farming in Space" was produced by the school's FIRST LEGO League (FLL) robotics and research team and was derived from their state award-winning presentation presented at the State FLL tournament held in Greensboro, NC in February 2019. FLL team member and Delta Academy girl, Gabrielle, said that receiving the check was going beyond anything she had ever expected when she became a member of the FLL team in October 2018. She went on to say that, "Winning the online public voting just shows that we (students) have the capability of reaching many with an important message. We are very big on communication skills, when you develop communication skills and use the right tools you can make an impact." This statement shows evidence of Gabrielle's self-efficacy in STEM, she believes that she has developed a STEM skillset that will advance her knowledge and success in STEM. According to Bandura (1997), Pintrich (2003), and Zimmerman (2000) self-efficacy

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influences task performance through goal setting and self-regulation during performance, in Gabrielle's own words "...we ran into road blocks in our research, but we kept digging deeper into our research. We read more, looked up words we didn't know and asked a lot of questions." Gabrielle's engagement in STEM has gone beyond her classes and beyond Delta Academy.

The success of winning the grand prize in the North Carolina middle schools category has drawn attention to Delta Academy and the tenacity of the Delta Academy girls. The school's CEO is seeking grant funding to provide further opportunities specifically for the NEAAAT Delta Academy (see Appendix M). This funding could support field trips to STEM businesses and industries. Community partners are excited about engagement to increase the number of girls in the STEM pipeline. Letters of support for the grant have been secured from the following:

- local Delta Sigma Theta Sorority, Inc. local alumnae chapter;

- the local university's School of Science, Mathematics & Technology including focuses on robotics, programming, 3D printing, aviation and aerospace;

- a regional high school robotics club that has consistently found success to compete in national robotics competitions and places an emphasis in engaging girls in robotics and programming; and

- the local Economic Development Commission.

The Delta Academy advisors will be working with the NEAAAT Business Alliance to identify STEM businesses and industries for STEM-focused partnerships for the 2019 – 2020 school year and beyond.

The work that has begun with Delta Academy, an all-female, peer-empowering, STEM-focused club has caught the attention of businesses, industries and institutions of higher education. The club leader anticipates that there will be an increase in partnerships in the future.

Implications for Practice

Focus on STEM engagement must shift to middle schools since research has shown (Gibbons & Boarders, 2011) that high school students are already set on a pre-determined path in their math and science curriculum based on their middle school performance. Acceleration must start sooner, and providing authentic STEM related learning experiences must begin at an early age to get girls excited about STEM careers. Several recommendations are listed below.

Recommendation for Middle School Girls

Because peer influences have an impact on confidence and interest, students must be aware of friend choice. Strategies that girls should consider include the following:

- Choose high achieving friends.

- Seek out STEM opportunities.

- Register for higher level math and science classes.

- Participate in STEM career fairs and science fairs.

- Participate in STEM competitions.

- Participate in volunteer opportunities.

Recommendations for Teachers

Because teacher influences can be a great influence on confidence and interest in STEM subjects, there are several strategies that teachers can employ to make an impact on middle school girls

- Provide female role models in STEM careers for young girls.

- Create opportunities to introduce girls to STEM careers.

- Integrate STEM concepts across the curriculum.

- Offer STEM competitive event (i.e. science fairs, robotics teams, Science Olympiad, etc.)

- Require productive group work opportunities with peers.

- Provide Project-Based Learning in math and science.

- Be open to partner with business and industry on real-world projects.

- Encourage after school STEM programming.

Recommendations for School Leaders

Because school leaders have a systemic perspective of the instructional operation of schools, it is important that school leaders approach STEM initiatives from a purposeful and systemic lens. School leaders can impact STEM education dramatically by making the following programming decisions:

- Integrate STEM concepts across the curriculum during curriculum review.

- Provide additional STEM opportunities for girls such as a systemic STEM Expo.

- Focus district goals on STEM initiatives.

- Establish a Work-Based Learning Coordinator to provide strategic support in seeking business and industry partnerships for student internships, teacher externships and provide students with robust career-based opportunities.

- Cultivate community partners to work with schools on STEM curriculum.

- Provide professional learning to teachers on STEM and integrating STEM concepts into curriculum.

Recommendations for Future Research

This study adds to the current literature focused on solutions aimed at increasing the number of women in STEM careers. Recommendations for future research include: studying the impact of forming a middle school boy's peer group focused on STEM.

It would also be interesting to conduct a longitudinal study surveying this same group of girls in high school, college, and then during their career. This type of study would allow insights on the developmental changes these young girls experience at different stages in their growth as they relate to interest in STEM.

Since there are studies that suggest STEM interest is related to skill acquisition at an early age, STEM related studies should be conducted on elementary students. These studies should be segregated K-2 and 3-5 since students are very developmentally different at these ages.

Conclusion

This study explored if an all-girl STEM-focused peer group, at NEAAAT, could increase efficacy and engagement in STEM. Adapting a risk and resiliency framework (Anthony et al., 2009), to guide program implementation, I followed the impact of protective factors by making initial observations about two affective constructs: engagement and efficacy. It was soon clear that a "sense of belonging" was significant to the success of the peer-empowered group, therefore belonging became a third construct of importance. Efficacy, engagement and belonging became the primary predictors for confidence and interest in STEM leading to an increase in efficacy and engagement.

The data collected in this study contributes to the research questions:

1. Can a STEM-focused peer group, at NEAAAT, increase self-efficacy perceptions about middle grades female minority students' success in STEM?

2. Can a STEM-focused peer group empower NEAAAT middle grades female minority students to become more engaged in STEM activities by developing the non-cognitive skills necessary for sustainability in STEM; such as creativity, teamwork, perseverance, resilience and motivation to learn?

The MISO S-STEM survey measured efficacy and revealed an increase in efficacy in STEM areas that were a focus in the program intervention, especially engineering and role-model influence. The Schlechty Questionnaire of Classroom Engagement revealed that the students were highly engaged and high committed in program intervention activities. There is much that can be done to impact girls at the middle school level in terms of efficacy and engagement in STEM. Each of these can be impacted greatly in and out of the classroom by implementing similar programming and strategies used by Delta Academy.

Final Thoughts

The economic need for increasing the involvement of minority women in STEM careers is imperative if we are to begin to close the economic income gaps which exist in our country among various demographic groups. Many companies are acknowledging the need to diversify the STEM workforce (Leins, 2018). Finding the most appropriate way to leverage this challenge is vital to the success of getting more young women interested in STEM careers. Self-efficacy impacts confidence which impacts the level of engagement which impacts success. Many solutions are found right in the classroom or in after-school programming. Therefore, providing effective training to STEM teachers is critical. Discussing ways to increase efficacy with counselors and teachers will impact girls' confidence. Finally, having all stakeholders on board; teachers, counselors, STEM businesses and industries, and STEM role models; will support an

effective systemic program that looks at the holistic needs of minority girls enabling them to be successful in STEM.

"Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results." – John Dewey

Authentic learning is the key to engage any demographic of students in STEM and build efficacy in STEM skills. This research highlighted practices that engaged students and built STEM efficacy through the delivery of authentic learning. The practices implemented in Delta Academy at NEAAAT reflect practices identified by Schelechty (2011) in ten design qualities that describe highly engaged classrooms.

1. Content and Substance – work that engages all students regardless of social or economic background.

2. Organization and Knowledge – information and knowledge should be arranged in clear, accessible ways that let students use the knowledge and information to address tasks that are important to them.

3. Product Focus – work that focuses on a product or performance that is significant to them.

4. Clear and Compelling Standards – students prefer knowing exactly what is expected of them, and how those expectations relate to something they care about.

5. Protection from Adverse Consequences for Initial Failures – students should be able to try tasks without fear of embarrassment, punishment, or implications that they're inadequate.

6. Affirmation of the Significance of Performance – students are more highly motivated when their parents, teachers, and fellow classmates make it known that the student's work is important.

7. Affiliation – work should permit, encourage, and support opportunities for students to work interdependently with others.

8. Novelty and Variety – students should be continually exposed to new and different ways of doing things.

9. Choice – students voice and choice lends itself to a degree of control over what they are doing, resulting in a greater commitment to the learning.

10. Authenticity – engagement increases when learning tasks are relevant to the student and mirror the real world.

Educators must purposefully develop relationships that will provide protections against failure and support a safe atmosphere of learning. It was important to Delta Academy girls that they felt safe and that they had a say in their learning (see Table 7).

Educators must become designers of authentic experiences where students

- engage with authentic tools of STEM so students can mimic or mirror the work of professionals,

- collaborate to solve real-world problems, and

- explore iterative cycles of learning that emphasize iteration and progress over completion.

If we are going to build efficacy and implement high levels of engagement then educators must shift focus from traditional methods of presenting curriculum to engaging, experiential learning that is authentic to the students' community and world. Systemic implementation of authentic

learning will improve teaching styles that can positively affect students' efficacy, confidence and

STEM identities. STEM engagement for all students can positively affect critical thinking skills

that will traverse many curriculum areas and employability skills.

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     Psychology, 25, 82-91.

APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
www.ecu.edu/ORIC/irb

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Tonya Little
CC:
          Jim McDowelle
Date: 3/11/2019
Re: UMCIRB 19-000093
          A Study to Increase Female Minority STEM Efficacy and Engagement at the Northeast Academy for
          Aerospace and Advanced Technologies

I am pleased to inform you that your research submission has been certified as exempt on 3/9/2019. This study is eligible for Exempt Certification under category #2A.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

APPENDIX B: LETTER OF SUPPORT FROM NEAAAT

NEAAAT

January 14, 2019

Dr. Marjorie Ringler, Chair
Department of Educational Leadership
East Carolina University
210 Ragsdale Hall
Greenville, NC 27858

Dear Dr. Ringler,

Please be advised that the Northeast Academy for Aerospace and Advanced Technologies (NEAAAT) Board of Directors has approved Tonya Little to conduct research at our school. Tonya is currently employed as the Executive Director of STEM Education of NEAAAT. In this role, she is tasked with facilitating the development and implementation of our STEM education efforts. Should you require further information, please do not hesitate to contact me.

Sincerely,

Dr. Andrew Harris, Chief Executive Officer
Northeast Academy for Aerospace and Advanced Technologies

Northeast Academy for Aerospace and Advanced Technologies
PO Box 2889 | Elizabeth City, NC 27906 | P: (252) 562-0653 | F:(252) 338-8546
www.northeastacademy.org

APPENDIX C: REQUEST TO PARTICIPATE LETTER

March 12, 2019

Dear Delta Academy Student and Parent:

I have enjoyed working with you during the 2018-2019 Delta Academy year. My work in STEM as covered some 27 years in education from being a classroom teacher, a school administrator, a county-wide STEM Coordinator, and now the Executive Director of STEM.

My current work in STEM will be the focus of my doctoral degree in Educational Leadership from East Carolina University. Over the next six weeks, I will be documenting Delta Academy's journeys in STEM. Because this is a part of my research and will be documented, your approval is needed.

The students will not be asked to do anything beyond what we normally do in Delta Academy.

The students will follow the already scheduled events for Delta Academy.

Thank you, in advance, for your cooperation in this matter. The work that I am doing will help inform others of how to engage youth in STEM activities.

Respectfully yours,
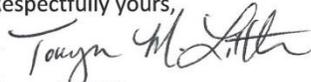
Tonya M. Little
Executive Director of STEM
Northeast Academy of Aerospace and Advanced Technologies

APPENDIX D: NCDPI NC STEM ATTRITBUTE RUBRIC MIDDLE SCHOOL

North Carolina Department of Public Instruction STEM Education Schools and Programs

NC STEM Attribute Implementation Rubric
MIDDLE SCHOOL

PURPOSE:

The NC STEM School/Program Implementation Rubric is built around the North Carolina Department of Public Instruction's (NC DPI) "STEM Attributes," which describe characteristics of a high quality STEM school. Ten Attributes apply to elementary and middle schools; the 11th Attribute applies to high schools only. Attributes are outlined on the following page.

The rubric articulates a common language for STEM program implementation strategies and to establish a continuum describing good-to-great STEM Schools/Programs. The middle school rubric can serve as a guide for middle schools or other organizations in the design and/or implementation of STEM leading and learning efforts. The rubric may be used to reflect on characteristics of a School/Program and to plan action steps for the future.

Additionally, NC DPI is using this rubric as the framework for the "NC STEM Recognition" Application. For more information on the NC STEM Recognition Application, visit: http://www.ncpublicschools.org/stem/

DESIGN:

The Middle School Implementation Rubric **contains ten (10) STEM Attributes**. Each Attribute is described individually on separate pages. Each Attribute page lists two - five "Key Elements," or key components of the Attributes (these are indicated in the rows). A four-point "Implementation Continuum" across the top of the page, ranges from "Early" to "Developing" to "Prepared" to "Model," and represents varying depths of implementation for each Key Element (these are the columns). Finally, the "Quality Indicators" describe the critical nature of a School/Program's implementation of a particular Key Element at a particular point along the implementation continuum (these are the cells).

ACKNOWLEDGEMENTS:

NC DPI acknowledges and appreciates The Friday Institute at North Carolina State University for their collaboration and the development of this rubric. Recommended citation for this rubric: Friday Institute for Educational Innovation (2013). *Middle School STEM Implementation Rubric*. Raleigh, NC: Author.

For more information about the rubric, please visit: The Friday Institute Evaluation Team http://eval.fi.ncsu.edu/

Public Schools of North Carolina
State Board of Education | Department of Public Instruction

STEM Attribute Implementation Rubric
MIDDLE SCHOOL

North Carolina Department of Public Instruction's **NC STEM Attributes**	Early	Developing	Prepared	Model
Integrated Science, Technology, Engineering and Mathematics (STEM) curriculum, aligned with state, national, international and industry standards				
1) Project-based learning with integrated content across STEM subjects				
2) Connections to effective in- and out-of-school STEM programs				
3) Integration of technology and virtual learning				
4) Authentic assessment and exhibition of STEM skills				
5) Professional development on integrated STEM curriculum, community/industry partnerships and postsecondary education connections				
6) Outreach, support and focus on underserved, especially females, minorities, and economically disadvantaged				
On-going community and industry engagement				
7) A communicated STEM plan is adopted across education, communities and businesses				
8) STEM work-based learning experiences, to increase interest and abilities in fields requiring STEM skills, for each student and teacher				
9) Business and community partnerships for mentorship, internship and other STEM opportunities that extend the classroom walls				
Connections with postsecondary education				
10) Alignment of student's career pathway with postsecondary STEM program(s)				
11) Credit completion at community colleges, colleges and/or universities*				

* Applies only to high schools.

APPENDIX E: DELTA ACADEMY FALL SCHEDULE 2018

(PRE-DELTA ACADEMY INTERVENTION)

	Aug 2018	Sept 2018	Oct 2018	Nov 2018	Dec 2018
Hands-On STEM Activities					
Hydroponics Grow Tower	8/22 -9/12				
Science Education Against Drug Abuse Partnership (SEADAP)		9/19 – 9/26			
Hispanic Heritage Month NASA ¡Latinos STEM Up!			10/2		
Elizabeth City State University Women in Mathematics Day			10/16		
4-H National Youth Science Day Code Your World Challenge			10/17		
Forensic Anthropology Who Owns These Bones?			10/31		
LittleBits Engineering				11/7	
World AIDS Day Epidemiology: Finding the Index Case					12/1
LittleBits Engineering Shark Tank Product Pitches					12/12
Role Model Experience					
Plant Geneticist Dr. Hortense Dodo Developed patented process to eliminate allergens from peanuts.	August				
Tahiya Manning PharmDoc Candidate Campbell University HBCU Graduate, Elizabeth City State University		September			
USCG Latina Role Model Aviation Maintenance Technician Coast Guard Petty Officer Katrina Cooley			October		
Nepris Session: Native America Female STEM Role Models				November	
Nepris Session: Cybersecurity					December

7 Habits of Leadership					
7 Habits of Leadership	8/22	9/19	10/10	11/7	12/5
Academic Wildly Important Goals	8/22			11/7	
Academic Self-Monitoring		9/19		11/7	
Celebrations! Awards and Achievements	8/29	9/26	10/31	11/14	
People Skills					
Etiquette	8/29				
Conflict Management		9/5			
Crucial Conversations Activity			10/3		
Analyzing Media Messages				11/28	
STEM Role Models: Who Do I Identify With?			10/31		

APPENDIX F: DELTA ACADEMY SPRING SCHEDULE 2019

	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019
Hands-On STEM Activities					
FLL FIRST Like a Girl Robotics	1/8				
Little Bits Engineering Challenge – Rotational Forces in Space	1/15				
Black History Month Stellar STEM Awards		2/5			
Crystallography Valentines		2/11, 2/13			
Women's History Month Projects			3/12		
Women's History Month Tea			3/23		
Science Education Against Drug Abuse Partnership (SEADAP) What can flatworms teach us about drug addiction (sucrose and caffeine)? – A Hands-On Lab Investigation Introduction to Henrietta Lacks Book Study (Ethics in Science)				4/9	
Robox Sumo – Engineering Design				4/13	
Science Education Against Drug Abuse Partnership (SEADAP) What can flatworms teach us about drug addiction (sucrose and caffeine)? – A Hands-On Lab Investigation Henrietta Lacks Book Study, Part 2				4/16	
Henrietta Lacks Book Study Conclusion				4/30	
Engineering Day at Kings Dominion					5/10

Role Model Experience					
Plant Geneticist Dr. Margaret Young Elizabeth City State University	January				
Nepris Gardening for Social Justice LaTaijah Powell A school located in the lower 9th ward of New Orleans, a known "food desert", built a garden and educated friends and family about healthy food choices.		February			
NC Senator Erica Smith, 3 term member of the North Carolina State Senate, representing District 3 – Beaufort, Bertie, Martin, Northampton, Vance, and Warren counties. Former Mechanical Engineer with The Boeing Company & STEM educator. Alicia Smith-Freshwater, Chief Biomedical Engineer/Healthcare Technology Manager for the VA Mid-Atlantic Health Care Network (VISN 6).			March		
Nepris The long-term effect of marijuana (drug) on a teenagers brain. Meenakshi Noll, MD, Ph.D				April	
Nepris Themed Engineering Anya Tyler Cincinnati, KY Design Engineer – Skyline Attractions LLC					May

7 Habits of Leadership					
7 Habits of Leadership	1/8	2/22	3/12	4/12	5/14
Academic Wildly Important Goals	1/8			4/12	
Academic Self-Monitoring		2/22		4/12	
Celebrations! Awards and Achievements			3/23		5/28
People Skills					
Conflict Management		2/11			
Crucial Conversations Activity			3/12		
Analyzing Media Messages				4/9	

APPENDIX G: SCHLECHTY'S LEVELS OF ENGAGEMENT

Levels of Student Engagement	
Engagement	High Attention + High Commitment
Strategic Compliance	High Attention + Low Commitment
Ritual Compliance	Low Attention + Low Commitment
Retreatism	No Attention + No Commitment
Rebellion	Diverted Attention + No Commitment

APPENDIX H: DELTA ACADEMY WOMEN'S HISTORY MONTH TEA EVENT

Figure 1 Advertisement for event that was sent to community stakeholders, Sorors, school staff, and parents

Figure 2 Delta Academy girls with NC Senator Erica Smith and Alicia Smith-Freshwater (second row) and Soror Tonya Little (far right)

APPENDIX I: DELTA ACADEMY GIRLS ARE BIOGEN SPARK VIDEO

BIOTECHNOLOGY CONTEST GRAND PRIZE WINNERS

SPARK video contest Grand Prize Winner!

Dear Tonya,
I am writing to inform you that your Biogen Foundation Spark video contest submission "**Biotechnology May Change Farming in Space**" has won the Grand Prize during our March public voting round! We were so impressed with your submission and so were the voters. Your school will receive $10,000 and your students will receive 3 GoPro cameras. Congratulations to you and your students!

A few details:

· This will be announced formally on April 9th on Biogen social media and on spark.biogenfoundation.com. **Please do not announce this publicly!** We are informing you early so that you can begin to plan to attend the recognition ceremony (details below)

· We will need you to **confirm acceptance of this prize within 3 days**, by Friday April 5, at 9:00 EDT

· **Please completely fill out both affidavit of eligibility forms attached by April 10** – nominator forms to be filled out by you- the nominating teacher- and school forms to be filled out by an authorized representative of your school (a principal, a director of finance, etc.). The "Official Rules" referenced in the affidavits can be found on the Spark website.

· Once we have received the forms, you will be eligible to receive the prize money, **$10,000** and **three GoPro video cameras**

Additionally, we are hosting a **recognition ceremony** for our four North Carolina Grand Prize winners during the North Carolina Science Festival – SciTech expo. This will take **place Saturday, April 13th at 2 p.m. at the NC Museum of Natural Science 11 W Jones St., Raleigh**. We would love to invite you, the students involved in the production of this Grand Prize winning video, their family members, and any other representatives from your school to attend the ceremony. The Biogen Foundation will be presenting a large novelty check to you and taking photos on stage during the event. **Please let us know as soon as possible if you are able to attend and how many people will be attending.** We will provide you with a parking map and additional information if you confirm your attendance.
Please reach out if you have any questions. Congratulations again!
Best regards,
The Biogen Foundation Team

APPENDIX J: DRIVER DIAGRAM FOR STEM EDUCATION SUCCESS

Core Principles for Success

1. Utilize a Professional Learning Community (PLC) which allows teachers to understand, recognize and work to eliminate risks to being successful in STEM and provide protections for achievement.
2. Utilize a PLC to evaluate STEM program implementation on a regular basis.
3. Promote high-quality engaging instructional strategies and practices that will inspire and motivate students through project-based learning, hands-on experiences, and formative assessments.
4. Enhance the quality of teacher-student feedback (formative assessment) to promote student resiliency towards learning.
5. Build cooperative relationships between education and the business community to connect students with authentic STEM experiences in and outside of school.
6. Provide experiences with STEM role models or STEM mentors.
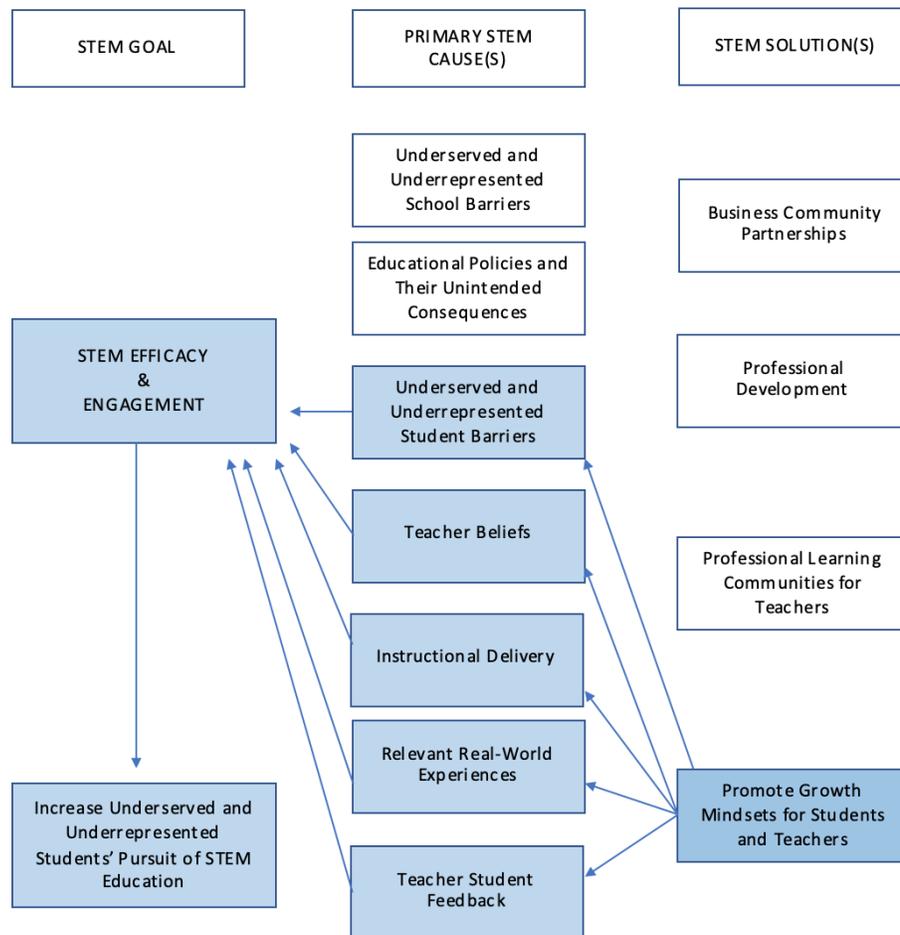
APPENDIX K: PDSA FEEDBACK

Table 3. Plan, Do, Study, Act Planning Document

P	PLAN: Identify the gap and the approach

Connections to STEM Role Models

Performance Data:

- Women fill close to 50% of all jobs in the US economy.
- Women fill less than 25% of science, technology, engineering and mathematics jobs.
- 32% of college women who enter STEM degree programs switch their majors to non-STEM fields by graduation (National Center for Education Statistics, STEM Attrition, 2013)
- 14% of U.S. Bachelor's Degrees in STEM in 2012 were awarded to people of color, even though they represent 33% of the college-age population. People of color received only 9% of Master's degrees and 6% of doctorates. (Change the Equation Vital Signs analysis of U.S. Department of Education Data)
- In a 2010 survey sponsored by Intel, 85% of teens age 13 to 18 said they were "very or somewhat confident in math and science," yet only 45% of U.S. high school graduates in 2011 were ready for college work in math and 30% were ready in science. (Math and Science Confidence Study, a Survey of 1,000 U.S. Teens Conducted Between September 24 and 28, 2010)

Data Analysis

1. To meet the overall goal, what is the most important area that needs improving and why?
   a. Positive behavior
   b. Increase academic achievement
   c. More positive attitude towards STEM, confident in themselves as STEM students, and more aware of careers in STEM
   d. Continued pursuit of STEM-related courses and extracurricular activities beyond the middle school setting
   e. Bridging relationships with women in STEM-related jobs

2. What approaches and strategies are contributing to success in this area and what does the data suggests this? *Guest speakers, interactions with female STEM role models*

3. What opportunities for improvement, gap or barriers are in this area? *March is Women's History Month, we are planning a tea with*

4. What seems to be the root cause of the problem and what data suggests this? *STEM role models present* *Lack of female minority STEM role models in our rural area.*

Reflection

Barriers would be the number of STEM female role models in our area.

1. What approaches/strategies could be deployed to address the root cause and support meeting the overall goal?

Women's History Month Tea scheduled for March 23, 2019

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2. What research was reviewed to support the use of these strategies/approaches? *Only 7.9% of mechanical engineers are women. (National*

3. What performance measures will be used to monitor impact of the approach/strategy? *Girls Surveys* *Collaborative*

4. What measure will be used to monitor fidelity of deployment of the strategy/approach? *Survey* *Project 2018)*

5. If funding is required, what funding source will be used? *Delta Sigma Theta Sorority, Inc., Elizabeth City Alumnae Chapter*

6. Is there any professional development needed? *NO, NEAAAT Executive Director of STEM has led PD in this area.*

Messaging: How will progress towards goals be communicated to stakeholders?

Newsletters, Social Media, Would be nice to have the

D	DO: Develop and implement deployment plan *event in the newspaper*

Step	List the specific steps your team will complete during this cycle.	Person(s) responsible for completion of the step.	Measure/Indicator (Used to monitor performance, involvement, or improvement)	Start Date	End Date
1	Once a week meeting of Delta Academy.	On-site teacher Executive Director of STEM Guidance Counselor Behavior Specialist	Sign in sheet for attendance Student Leadership Notebook	3/12 2019	4/2 2019
2	Monitoring of progress reports and report cards	Guidance Counselor School Data Manager	Progress reports 3/12/19 Report cards 4/12/19	3/12/19	4/12/19
3	Hands-On STEM Engagement (activities, labs)	Executive Director of STEM	Survey level of interest in STEM Activities Engagement	3/12 2019	4/2 2019
4	Connections with female STEM role models	Executive Director of STEM Guidance Counselor	Survey level of interest	3/23 2019	3/23 2019
5	Pursuit of ST extracurricular activities beyond school	Guidance Counselor	Documentation of STEM extracurricular activities, summer camps, and high school STEM-related courses and programs	3/12 2019	4/2 2019

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S	Study: Analysis of data after implementing an approach

1. What worked and how do you know? *Girls were very engaged in the planning and of the Using tea, participation* *meeting the role models.*

2. What didn't work and how do you know? *Never enough time, it seems.*

3. Do we need additional assistance as we look at the next cycle? *STEM teachers - guidance counselor* *More involvement from school staff*

4. What improvements can be made to the following areas: (a) Approach, (b) Strategy, (c) Process, (d) Support, (e) Professional development, (f) Monitoring. *More involvement from school staff*

Reflect on the answers in 1-4 above and place an X in front of which option best describes what you will do in your plan for the next cycle.

	Target goal has been met and is changed to a new target goal. *Met the interaction goal for this 3 wk period*
X	Target goal is not met but current plan is effective so we will continue current plan and repeat it for next cycle. *We are still targeting more STEM Role Model interactions*
	Target goal not met so we will continue current plan. We will make improvements to the plan on what didn't work as identified in #2 and #4 above.
	Target goal not met and information indicates that we need to abandon current plan and identify a new approach.

Only 7.9% of mechanical engineers are women. Delta Academy girls met 2 - a biomechanical engineer and an aircraft mechanical engineer.

A	Act: How will the group move forward based upon analysis of data?

We have already scheduled Role Model Interactions for the next 3 week cycle.

Measures of Improvement. The following tools will be utilized to analyze efficacy and engagement.

Tool	Measurement
MISO S-STEM Survey	STEM Efficacy
Student Engagement Instrument	Measures five subtypes of student engagement (teacher-student relationships, control and relevance of school work, peer support for learning, future aspirations and goals, and family support for learning)
Questionnaire of Classroom Engagement	Measures levels of engagement along an identified continuum of educational engagement; authentic engagement, ritual engagement, passive engagement, retreatism and rebellion.

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APPENDIX L: #ILOOKLIKEANENGINEER CAMPAIGN

Goal: The goal of this activity is to give the girls an opportunity to think critically about stereotypes that exist around STEM careers in general, and women in STEM, and how this might impact their own career choice. Girls will have a chance to practice working in a team to organize their thoughts about the #ILookLikeanEngineer campaign, decide what the campaign means for them, and to create a presentation video that best conveys the message, #ILookLikeaSTEMStudent. As a group, they will be voting on the video they think sends the most powerful message.

Tasks:

1) In groups of 3-4, girls should have already viewed the #ILookLikeanEngineer PowerPoint and watched the short video about the woman who started the campaign: https://www.nbcnews.com/video/female-engineer-who-started-ilooklikeanengineer-on-silicon-valley-diversity-582098499525

2) Each group should create a short video (~1 to 2 minutes) inspired by the # ILookLikeanEngineer campaign. This can be a Google Slideshow which is projected/filmed, a video where they are talking directly to the camera, a skit which is filmed or something else they come up with. The final product must be in video form. Below is a list of questions that my help the girls decide what they want to say in their video.

   a) What are the impacts of stereotypes of women in STEM?
   b) What do current statistics tell us about women in STEM?
   c) Why is it important to have diversity in STEM?
   d) What opportunities can STEM give you as you look towards college/your career?
   e) What challenges or negative experiences have you had related to STEM and how have you overcome them?
   f) What would you say to someone who said you shouldn't work in a STEM field because you were female or too pretty or too young?

   As the girls are brainstorming, encourage them to think about what elements they should include in their video in order communicate a powerful message and create an emotional response in the viewer. Encourage them to incorporate elements such as images and music to enhance their storytelling. Remind them that these videos should share their personal stories and connect with their own feelings and life experiences. All members of the group should be actively involved in this process. Each group should also come up with a name for their video.

   A simple rubric for judging the final product should be distributed to the girls when they begin step 2. They can use this to help design a strong video as well as to help them when they judge each other's work and voting for their favorite.

3) Once all videos are finished, they will be shown to the class. Each group will play their video and briefly explain what role each member had in the video making process. The girls will anonymously vote for their favorite video created by a group other than their own (this can be done by writing the name of their favorite video on a sheet of paper). Results will be tallied and if a run-off is needed, a second vote can occur (if time the top 2 videos can be reshown). The top video will be shown at future events and in future years of this program.

Video Evaluation Rubric

	Excellent	**Good**	**Needs Improvement**
Power of the Message	Video has a strong message that is easy to understand, the story connected with real feelings and life experiences from the girls in it	Video seems to have a message but was missing feelings and genuine experiences OR feelings and experiences were mentioned but a unifying theme was missing	No theme was evident and personal feelings and life experiences were not taken into account
Video elements	Elements such as images, data, music and words worked together to tell a story with an emotional impact	Only one element was used to tell the story OR multiple elements were used but did not work harmoniously	One element was used but it did not tell an impactful story
Creativity	Video was unique and told a story in a new way	Video was similar to ones created in the past	Video was the same as past examples
Collaboration	All team members played a part in creating the video	Most members seemed to be involved	Only one member seemed to be trying in the group

APPENDIX M: BURROUGHS WELLCOME FUND DELTA ACADEMY GRANT

PROPOSAL SNAPSHOTS

BURROUGHS WELLCOME FUND
STUDENT STEM ENRICHMENT PROGRAM
SIGNATURE PAGE

PROGRAM DIRECTOR NAME (LAST, FIRST): Tonya Little	
POSITION TITLE: Executive Director of STEM Education	APPLYING ORGANIZATION: Northeast Academy for Aerospace and Advanced Technologies
EMAIL ADDRESS: tonyalittle@northeastacademy.org	
TELEPHONE NUMBER: (252) 562-0653	MAILING ADDRESS:
FAX NUMBER: (252) 621-3509	PO Box 2889 Elizabeth City, NC 27906

PROGRAM DIRECTOR ASSURANCE:
I certify that the statements herein are true, complete, and accurate to the best of my knowledge. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. I agree to accept responsibility for the conduct of the project and to provide the required progress reports if a grant is awarded as a result of this application.

SIGNATURE OF APPLICANT:
(In ink. "Per" signature not acceptable.)

Tonya Little

DATE: 04/15/2019

DATES OF PROPOSED PROJECT (MM/DD/YYYY)		PROPOSED BUDGET (MAXIMUM OF $180,000):
FROM	THROUGH	
2020-03-01	2023-06-30	$179,800

PROGRAM COORDINATOR NAME: *(if different from the Program Director)*	INSTITUTIONAL SIGNING OFFICIAL NAME: Dr. Andrew Harris
TITLE:	TITLE: Chief Executive Officer
MAILING ADDRESS:	MAILING ADDRESS: PO Box 2889, Elizabeth City, NC 27906
EMAIL ADDRESS:	EMAIL ADDRESS: ceo@northeastacademy.org
TELEPHONE NUMBER:	TELEPHONE NUMBER: (252) 562-0653
FAX NUMBER:	FAX NUMBER: (252) 621-3509
SIGNATURE OF PROGRAM COORDINATOR: *(In ink. "Per" signature not acceptable.)* DATE:	**SIGNATURE OF SIGNING OFFICIAL:** *(In ink. "Per" signature not acceptable.)* *Andrew Harris* DATE: 2019-04-15
PROGRAM COORDINATOR ASSURANCE: I certify that the statements herein are true, complete, and accurate to the best of my knowledge, and accept the obligation to comply with the grantor's terms and conditions if a grant is awarded as a result of this application. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties.	INSTITUTIONAL SIGNING OFFICIAL ASSURANCE: I certify that the statements herein are true, complete, and accurate to the best of my knowledge, and accept the obligation to comply with the grantor's terms and conditions if a grant is awarded as a result of this application. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties.

SSEP 12-2018

[Reset Form]   [Print Form]

Executive Summary

As a regional public STEM school for students in grades 6-12, NEAAAT currently enrolls 435 students residing in 8 counties in the rural Northeast. NEAAAT sets as its target population students who will become the first in their families to earn a college degree, students who are living in poverty, and students who have been traditionally underrepresented in STEM fields, such as females and racial/ethnic minorities.

Early on, we noticed an intense lack of STEM self-efficacy across the student body, and this issue was strongest among students of the target population. To address this issue, our school partnered with the Elizabeth City Alumnae Association of Delta Sigma Theta Sorority, Inc., a nationally recognized not-for-profit organization whose purpose is to aid and support social and education endeavors through established programs in local communities throughout the world. The program's goals are to increase the number of students, especially girls, that are successful academically in STEM classes and foster in those students the confidence to pursue STEM opportunities beyond their school. To accomplish these goals, Delta Academy successfully leverages myriad partnerships with local programs that have a STEM focus, established STEM programs such as 4-H, local institutions of higher education, businesses and industries to provide students access to local STEM resources and STEM role models--a key factor shown to significantly increase STEM self-efficacy.

NEAAAT's Delta Academy pilot program currently serves 25 students through weekly engagement in afterschool STEM activities and weekend events that are aligned to the NC Standard Course of Study and Next Generation Science Standards. After the first year of implementation, NEAAAT administrators have found that the Delta Academy program has resulted in significant gains for students in the areas of STEM efficacy, career awareness, and engagement. Due to these early successes and positive feedback from students, local interest in the program among parents and students is soaring. Unfortunately, NEAAAT student and parent survey data show that transportation is a major barrier to student participation.

To meet this immediate need in our region, we propose to expand our Delta Academy program to reach at least 100 students annually by August 2021 and at least 300 students annually by July 2023 through the Burroughs Wellcome Fund Student STEM Enrichment Program. Specifically, grant funds provided by this program will be used to hire additional program facilitators, purchase additional supplies, increase students' exposure to STEM careers and post-secondary opportunities, and provide after school transportation. After the grant period, NEAAAT will sustain the Delta Academy program through funding from local partnerships, general operating funds, and afterschool fees paid by non-FRL students. Overall, our objectives are to increase student STEM self-efficacy, engagement, and academic performance, with an emphasis on students of our target population.

NEAAAT's Delta Academy Program consists of activities aligned to four main areas: hands-on, inquiry-based STEM activities, role model experiences with STEM professionals, leadership development opportunities, and "people skills" (i.e. soft skills) development.

Hands-on, inquiry based STEM activities. NEAAAT's Delta Academy program utilizes established, research-based labs and activities, as well as innovative, new opportunities designed by NEAAAT educators. For example, students are engaged in programming activities through the FIRST Lego League, and they explore the effects of drugs (caffeine and sugar) on body systems through the Science Education Against Drug Abuse Partnership (SEADAP) lab activities. Burroughs Wellcome funding will make possible monthly place-based activities, so that participants can make connections between classroom content and the world in which they live.

Across all of these activities, students will gain knowledge and skills that are essential for the investigative process. Tools that are frequently used include the engineering design process adopted by NC State University (Ask, Imagine, Plan, Create, Improve) and variants of the traditional scientific method, such as the iterative process described by Dr. Robert Sanders of the University of California-Berkeley. Activities require students to learn to follow laboratory protocols, analyze and interpret results, determine logical "next steps" in the investigative process based on their results, and effectively communicate their findings with diverse audiences. By participating in these activities, students will build confidence in their abilities to successfully engage in the work of STEM, which is critical in building overall STEM self-efficacy, and they will build technical skills and content knowledge, which will lead to increased performance in STEM courses.

Role model experiences. Through activities like Nepris video conference sessions with STEM industry professionals, small group and one-on-one conversations with practicing scientists and legislators, and job shadowing, participants gain greater awareness of the types of STEM jobs that exist as well as the myriad entrance pathways to STEM careers. Program facilitators place emphasis on scheduling activities that place professionals from traditionally underserved and underrepresented backgrounds with students so that students might see themselves as future STEM professionals. These activities will take the form of field trips to industry and post-secondary partners, site visits to various government and non-profit organizations, and events held on the NEAAAT campus.

Leadership development opportunities. Program participants gain insight about positive leadership principles through activities aligned to Dr. Stephen R. Covey's seminal text, *Seven Habits of Highly Effective People*, and the established curriculum materials that accompany the text. These materials have been proven over and over to build leadership skills in students, and

they are currently in place across hundreds of *Leader in Me* schools around the globe. Sample activities include case study examinations, role playing, career inventories, and goal setting.

People skills development. STEM employers and employers in general often state that *people skills*, sometimes referred to as *soft skills* or *employability skills,* are critical to success in the workforce. To grow these skills in students, NEAAAT's Delta Academy program implements activities that familiarize students with widely known and accepted strategies that foster a positive workplace environment, such as the strategies described within the *Crucial Conversations* framework for conflict resolution and feedback.

Staff Capacity

NEAAAT employs a highly qualified and well trained staff capable of designing, implementing, refining, and disseminating cutting edge instructional programming. This superlative team of educators inspires and prepares students to solve real world problems through inter- and trans-disciplinary projects that emphasize teaming and professional skills. Though additional facilitators will be hired as participation increases, three key team members will be engaged in the project at the outset.

Tonya Little currently serves as Executive Director of STEM Education at NEAAAT, as well as the founder of the NEAAAT-Delta Academy program. She holds a B.S. in Biology, a Master of School Administration, and is currently defending her completed dissertation for the Doctor of Education degree. The Delta Academy pilot program has been the focus of her doctoral study, which has now concluded with impressive results that include significant gains in STEM self-efficacy and engagement. She will coordinate all program activities, including setting schedules of activities and events, recruiting students and staff, and generating all communications and materials.

Dr. Andrew Harris, Chief Executive Officer, holds a B.S in Biology, M.S. in Biology, and a Doctor of Education in Educational Leadership. His recent doctoral study focused on strategies to achieve demographically balanced enrollment, with a focus on successful recruitment of underserved and underrepresented populations. He will serve as the Program Evaluator and will oversee all measurement activities.

Caitlin McDonald is a middle grades Design Thinking teacher at NEAAAT. Previously, she designed and implemented supplemental programs and hands-on activities for various organizations, such as the Pocosin Lakes Arts Center and Southern Illinois University-Edwardsville. She holds a B.S. in Art Education, as well as Bachelor and Master of Fine Arts degrees.

Degrees and current certifications for all current personnel can be found at www.northeastacademy.org/about/our-team.

Project Narrative

Driving Goal

The driving goal of this project is to increase STEM self-efficacy and engagement across our target population, which is composed of students who will become the first in their families to earn a college degree, students who are living in poverty, and students who have been traditionally underrepresented in STEM fields. Specifically, we endeavor to:

1. Increase participation of target population students (described within the Executive Summary section) in the Delta Academy STEM enrichment program to 300 students annually by 2023;
2. Increase students' STEM self-efficacy, so that at least 80% of all participants rate themselves at the Confident level on the MISO S-Stem Survey at program completion;
3. Increase overall STEM engagement, such that at least 75% of all participants seek opportunities outside of regular classroom and program activities within 1 year of participation based on post-survey data; and,
4. Increase NEAAAT-enrolled students' performance in STEM courses by at least 5 points within 1 year of participation, as measured by report card data.

To accomplish these objectives, NEAAAT will expand access to the established and successful Delta Academy pilot program over the course of three years. The project's goal is to have 100 students engaged in Year 1 through a combination of afterschool and summer programs, 200 students in Year 2, and 300 students by the end of the third year of the grant. Delta Academy will target both currently enrolled and non-enrolled students in grades 6-8 from across our school's 6 county recruitment zone, which includes Chowan, Gates, Perquimans, Pasquotank, Camden, and Currituck counties.

Transportation for students will be provided using NEAAAT busses to maximize accessibility for all students. Student sessions will be scheduled once weekly after school, on the weekends and during the summer months, utilizing the NEAAAT school building on the campus of Elizabeth City State University and multiple partner organizations across the region, such as Museum of the Albemarle, USCG Air Station Elizabeth City, and others. We are fortunate to have the support of our regional Economic Development Commission and the Elizabeth City Alumnae Association of Delta Sigma Theta Sorority, Inc., who have already provided significant assistance in connecting students with local business and industry partners.

Content -- Hands-on STEM Activities, Role Model Experiences, Leadership and People Skills

Burroughs Wellcome Fund
SSEP BUDGET FORM

Program: NEAAAT-Delta Academy: Expanding Access to STEM

Duration of Program: From: March 1, 2020 To: 6/30/23

Institution: Northeast Academy for Aerospace and Advanced Technologies

	Year 1	Year 2	Year 3
PERSONNEL EXPENSES: (Itemize salaries and benefits for professional staff to be supported through the grant.)			
Delta Academy Coordinator, Salary (5%)	$4,250.00	$4,250.00	$4,250.00
Delta Academy Coordinator, Fringe Benefits	$1,100.00	$1,100.00	$1,100.00
Delta Academy Facilitators Stipends	$18,000.00	$24,000.00	$30,000.00
TOTAL PERSONNEL	**$23,350.00**	**$29,350.00**	**$35,350.00**
STIPENDS: (List stipends to be given to students participating in the program or to teaching assistants.)			
TOTAL STIPENDS	**$0.00**	**$0.00**	**$0.00**
INSTRUCTIONAL SUPPLIES/MATERIALS/EQUIPMENT: (Itemize by category supplies and materials purchased through the grant—categories may include lab supplies, instructional supplies, etc. List equipment purchases.)			
Instructional Supplies	$5,000.00	$7,500.00	$10,000.00
TOTAL INSTITUTIONAL SUPPLIES/			

Program: NEAAAT-Delta Academy: Expanding Access to STEM

Duration of Program: From: March 1, 2020 To: 6/30/23

Institution: Northeast Academy for Aerospace and Advanced Technologies

	Year 1	Year 2	Year 3
FOOD/TRANSPORTATION/LODGING: (List funds requested for food, transportation, or lodging—residential programs may provide lodging, while other programs may provide transportation.)			
Site Visits to Industry Partners and Post-Secondary Institutions (4 per year)	$4,000.00	$6,000.00	$8,000.00
Site-based experential learning trips across the region (1 per month)	$1,500.00	$2,000.00	$250.00
Daily afterschool transportation to regional hubs	$12,000.00	$15,000.00	$15,000.00
TOTAL FOOD/TRANSPORTATION/ LODGING	**$17,500.00**	**$23,000.00**	**$23,250.00**
EVALUATION:	**$0.00**	**$0.00**	**$0.00**
OTHER: (Other line items may include expenses for advertising/recruitment, dissemination, etc.)			
Advertising, recruitment, and publications	$2,500.00	$2,000.00	$1,000.00
TOTAL OTHER	**$2,500.00**	**$2,000.00**	**$1,000.00**
TOTAL DIRECT COSTS PER YEAR (Requested from BWF):	**$48,350.00**	**$61,850.00**	**$69,600.00**
TOTAL REQUESTED FROM BWF:			**$179,800.00**

OTHER FUNDING SOURCES FOR THE PROGRAM (IN-KIND, ETC.):

Evaluation will be conducted by district personnel to reduce expenses.

Elizabeth City Alumnae Chapter
Delta Sigma Theta Sorority, Incorporated
Post Office Box 1709
Elizabeth City, NC 27906
March 28, 2019

Andrew Harris
NEAAAT
PO Box 2889
Elizabeth City, NC 27909

Dear Mr. Harris:

The Elizabeth City Alumnae Chapter of Delta Sigma Theta Sorority, Incorporated enthusiastically supports Northeast Academy for Aerospace and Advanced Technologies' (NEAAAT) *Delta Academy* and the benefits it offers to our underrepresented and underserved females in STEM in Northeastern North Carolina. We support the school's application to Burroughs-Wellcome and are committed to bringing out time, skills and resources to this project, as detailed below.

Our region's educational system is often stretched beyond its capacity. This fact is reflected in regional test scores, graduation rates, and levels of completed higher education. Schools in Northeastern NC that can offer sufficient programming to excite our youth in STEM are rare but we believe underserved students with opportunities to explore and learn that are currently unavailable to them while simultaneously developing critical job skills.

The Elizabeth City Alumnae Chapter of Delta Sigma Theta Sorority, Incorporated currently works with NEAAAT as a community STEM stakeholder by providing access to after school STEM activities and STEM role models. Delta Academy is part of our national organization's Five-Point Programmatic Thrust in the areas of educational development, economic development, international awareness and involvement, physical and mental health, and political awareness and involvement. Since 1996, our national organization has supported opportunities to enrich and enhance the education that our young teens receive in public schools across the nation. Specifically, we augment their scholarship in math, science, and technology, their opportunities to provide service in the form of leadership through service learning.

We ask Burroughs-Wellcome to support this program and its goals. The Elizabeth City Alumnae Chapter of Delta Sigma Theta Sorority, Incorporated has a strong working relationship/partnership with NEAAAT and believes in its ability to competently carry out the activities and goals of this proposal.

Thank you for your consideration and continued collaboration

Most Sincerely,
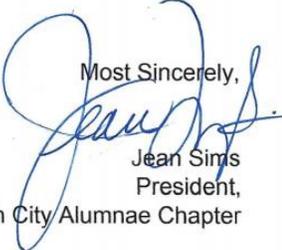
Jean Sims
President,
Elizabeth City Alumnae Chapter

ECSU
ELIZABETH CITY STATE UNIVERSITY
FOUNDED 1891

03/26/2019

Andrew Harris
NEAAAT
PO Box 2889
Elizabeth City, NC 27909

Dear Andrew,

Elizabeth City State University (ECSU) and its School of Science, Mathematics & Technology enthusiastically supports Northeast Academy for Aerospace and Advanced Technologies' (NEAAAT) *Delta Academy* and the benefits it offers to our underrepresented and underserved females in STEM in Northeastern North Carolina. We support the school's application to the Burroughs Wellcome Fund and are committed to bringing out time, skills and resources to this project, as detailed below.

Our region's educational system is often stretched beyond its capacity. This fact is reflected in regional test scores, graduation rates, and levels of completed higher education. Schools in Northeastern NC that can offer sufficient programming to excite our youth in STEM are rare, but we believe underserved students with opportunities to explore and learn that are currently unavailable to them while simultaneously developing critical job skills.

ECSU currently works with NEAAAT as a community STEM stakeholder by providing classes and equipment in the areas of robotics, programming, 3D printing, aviation, aerospace and much more. We will also work with NEAAAT to facilitate career exploration, female role models in aviation and aerospace, and experiences in working with authentic tools of the aerospace and aviation industry.

ECSU has a strong working relationship with NEAAAT and believes in its ability to competently carry out the activities and goals of this proposal.

Thank you for your consideration.

Sincerely,

Kuldeep Rawat, Ph.D., AvMP
Endowed Professor & Dean

Life, Physical Sciences, Mathematics & Technology
1704 Weeksville Rd. Elizabeth City, NC 27909

p: 252. 335. 4729 | f: 252. 335. 3760 | www.ecsu.edu

November 9, 2018

Dr. Andrew Harris, CEO
Northeast Academy for Aerospace and Advanced Technologies
PO Box 2889
Elizabeth City, NC 27906

Dear Dr. Harris,

I am writing to express support for the Northeast Academy for Aerospace and Advanced Technologies (NEAAAT) Business Alliance. Please accept this letter as a commitment on behalf of the Elizabeth City-Pasquotank County Economic Development Commission (EC-PC EDC) to support NEAAAT's efforts to collaborate with the local business community.

NEAAAT is a very important community partner and critical to our economic development efforts to provide the education and skills needed to retain, attract, and help local businesses expand. You can count on EC-PC EDC's support to help facilitate field trips, job shadowing, and internship opportunities between NEAAAT and local and regional businesses.

I look forward to supporting these efforts and others as NEAAAT continues to grow and make a positive impact on the Northeast Region of North Carolina.

Respectfully,
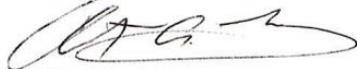
Christian A. Lockamy
Director of Economic Development
Elizabeth City-Pasquotank County
252.339.7902 – calockamy@ecpcedc.com

PITT COUNTY ROBOTICS

FRC TEAMS – 2642 & 2682

April 4, 2019

Andrew Harris
NEAAAT
PO Box 2889Elizabeth City, NC 27909

Dear Andrew,

Pitt County Robotics and their FRC teams (Pitt Pirates and Boneyard Robotics) enthusiastically support Northeast Academy for Aerospace and Advanced Technologies' (NEAAAT) *Delta Academy* and the benefits it offers to our underrepresented and underserved females in STEM in Northeastern North Carolina. We support the school's application to Burroughs-Wellcome and are committed to bringing out time, skills and resources to this project, as detailed below.

Our region's educational system is often stretched beyond its capacity. This fact is reflected in regional test scores, graduation rates, and levels of completed higher education. Schools in Northeastern NC that can offer sufficient programming to excite our youth in STEM are rare but we believe underserved students with opportunities to explore and learn that are currently unavailable to them while simultaneously developing critical job skills.

Pitt County Robotics currently works with NEAAAT as a community STEM stakeholder by supporting their growing Robotics programs (FRC and FLL). We have worked with them for the past few years providing training, equipment and demonstrations in the areas of robotics. We will continue to work with NEAAAT to facilitate career exploration, female role models in engineering and experiences working with authentic tools of the engineering industry.

Pitt County Robotics has a strong working relationship with NEAAAT and believes in its ability to competently carry out the activities and goals of this proposal.

Thank you for your consideration.

Sincerely,

William J. McClung
Coach/Mentor
Pitt County Robotics
Juhling@suddenlink.net
252-347-3498

2700 River Chase Drive
Greenville, NC 27858
Tel – 252-347-3498

APPENDIX N: PLAN, DO, STUDY, ACT PLANNING DOCUMENT

P	PLAN: Identify the gap and the approach

Performance Data:
- Women fill close to 50% of all jobs in the US economy.
- Women fill less than 25% of science, technology, engineering and mathematics jobs.
- 32% of college women who enter STEM degree programs switch their majors to non-STEM fields by graduation (National Center for Education Statistics, STEM Attrition, 2013)
- 14% of U.S. Bachelor's Degrees in STEM in 2012 were awarded to people of color, even though they represent 33% of the college-age population. People of color received only 9% of Master's degrees and 6% of doctorates. (Change the Equation Vital Signs analysis of U.S. Department of Education Data)
- In a 2010 survey sponsored by Intel, 85% of teens age 13 to 18 said they were "very or somewhat confident in math and science," yet only 45% of U.S. high school graduates in 2011 were ready for college work in math and 30% were ready in science. (Math and Science Confidence Study, a Survey of 1,000 U.S. Teens Conducted Between September 24 and 28, 2010)

Data Analysis

1. To meet the overall goal, what is the most important area that needs improving and why?
   a. Positive behavior
   b. Increase academic achievement
   c. More positive attitude towards STEM, confident in themselves as STEM students, and more aware of careers in STEM
   d. Continued pursuit of STEM-related courses and extracurricular activities beyond the middle school setting
   e. Bridging relationships with women in STEM-related jobs
2. What approaches and strategies are contributing to success in this area and what does the data suggests this?
3. What opportunities for improvement, gap or barriers are in this area?
4. What seems to be the root cause of the problem and what data suggests this?

Reflection

1. What approaches/strategies could be deployed to address the root cause and support meeting the overall goal?
2. What research was reviewed to support the use of these strategies/approaches?
3. What performance measures will be used to monitor impact of the approach/strategy?
4. What measure will be used to monitor fidelity of deployment of the strategy/approach?
5. If funding is required, what funding source will be used?
6. Is there any professional development needed?

Messaging: How will progress towards goals be communicated to stakeholders?

D	DO: Develop and implement deployment plan				
Step	List the specific steps your team will complete during this cycle.	Person(s) responsible for completion of the step.	Measure/Indicator (Used to monitor performance, involvement, or improvement)	Start Date	End Date
1	Once a week meeting of Delta Academy.	On-site teacher Executive Director of STEM Guidance Counselor Behavior Specialist	Sign in sheet for attendance Student Leadership Notebook		
2	Monitoring of progress reports and report cards	Guidance Counselor School Data Manager	Progress reports Report cards		
3	Hands-On STEM Engagement (activities, labs)	Executive Director of STEM	Survey level of interest in STEM Activities Engagement		
4	Connections with female STEM role models	Executive Director of STEM Guidance Counselor	Survey level of interest		
5	Pursuit of ST extracurricular activities beyond school	Guidance Counselor	Documentation of STEM extracurricular activities, summer camps, and high school STEM-related courses and programs		

S	Study: Analysis of data after implementing an approach
1.	What worked and how do you know?
2.	What didn't work and how do you know?
3.	Do we need additional assistance as we look at the next cycle?
4.	What improvements can be made to the following areas: (a) Approach, (b) Strategy, (c) Process, (d) Support, (e) Professional development, (f) Monitoring.

Reflect on the answers in 1-4 above and place an X in front of which option best describes what you will do in your plan for the next cycle.

	Target goal has been met and is changed to a new target goal.
	Target goal is not met but current plan is effective so we will continue current plan and repeat it for next cycle.
	Target goal not met so we will continue current plan. We will make improvements to the plan on what didn't work as identified in #2 and #4 above.
	Target goal not met and information indicates that we need to abandon current plan and identify a new approach.

A	Act: How will the group move forward based upon analysis of data?

Measures of Improvement. The following tools will be utilized to analyze efficacy and engagement.

Tool	Measurement
MISO S-STEM Survey	STEM Efficacy
Student Engagement Instrument	Measures five subtypes of student engagement (teacher-student relationships, control and relevance of school work, peer support for learning, future aspirations and goals, and family support for learning)
Questionnaire of Classroom Engagement	Measures levels of engagement along an identified continuum of educational engagement; authentic engagement, ritual engagement, passive engagement, retreatism and rebellion.