A Causal-Comparative Quasi-Experimental Study: Self-Efficacy and Underrepresented Minorities (URMs) Success in High School STEM Advanced Academic Placement (AAP) Courses

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Abstract

The problem addressed in this study was a that there is a lower amount of young underrepresented minorities (URMs)–African American/Black and Latino/Hispanic students–proficient in science, technology, engineering and mathematics (STEM) who are prepared to enter STEM professions compared to their Asian and Caucasian/White (non-URMs) peers; specifically minority's high school youth who are largely in low-socioeconomic-status (SES) groups of which lack student proficiency and self-efficacy in STEM advanced academic placement (AAP) courses. A stratified, random sampling of data were used. The causal-comparative quasi-experimental design method used a secondary analysis of the outcome variables collected by the Department of Education's survey tool, education data analysis tool (EDAT), during a national longitudinal study utilizing a multivariate analysis of variance (MANOVA). The research question addressed the difference in self-efficacy and STEM education outcomes between URMs and non-URMs. Three themes emerged: college readiness, self-efficacy, and resource scarcity. A significant finding was one's science self-efficacy is linked to STEM outcomes as an identified gap in academic performance. Research findings can guide future policies for STEM reaching youth by pivoting on demographic and self-efficacy variables. The study found that a students' success in STEM AAP courses was linked to self-efficacy level, specifically for URMs who came from majority low-SES areas. The statistical results of the multivariate regression analyses and findings provide a viable solution for targeting a pipeline of diverse talent through STEM education for the next generation workforce. Recommendations include practical application for STEM program assessment, and further research studies for shaping policy for STEM education and outreach initiatives that pipeline the next generation national security defense workforce in government, industry and academia.

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Chapter 1: Introduction

The U.S. faces a disparity in academic achievement between specific demographic groups in science, technology, engineering, and mathematics (STEM) throughout the education continuum (Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015). The disparity resulted in a future workforce crisis impacting the nation's ability to access STEM talent. Science, technology, engineering, and mathematics (STEM) occupations increased by 14 percent compared to 2 percent in non-STEM occupations (Castleman, Long & Mabel, 2018). Employers across government and industry seek talent in STEM-proficient occupations that are projected to have above-average growth over the next decade (Fayer, Lacey, & Watson, 2017; Noonan, 2017). Furthermore, the workforce demographics anticipate a significant change in the next decade resulting in minority populations becoming the majority (Noonan, 2017). Minority populations were also referred to as underrepresented minorities (URMS) and were defined in this study as member's race/ethnicity characterized by two dichotomous composite variables, *African American*/*Black*-composite or *Latino/Hispanic*-composite demographics. As the U.S. majority population demographic shifts, the nation's workforce must adjust to include minority groups in the STEM workforce and reduce the academic gap (Redmond-Sanogo, Angle & Davis, 2016). The national STEM workforce crisis hinges on the need to better prepare the nation's diverse population of students in STEM proficiency in advanced mathematics, science, and computer science with high self-efficacy to enter STEM careers with global competitiveness (Sadler, Sonnert, Hazari & Tai, 2014; Wang, 2013). Self-efficacy was defined in this study as one's belief in the ability to achieve mathematics and science education outcomes successfully.

According to the U.S. Census Bureau data, the current minority youth population in America's youth will become the new majority population in 2020 and will reach the workforce by 2040 (Day, 1996; Fayer et al., 2017; Noonan, 2017). Industry and federal workforce have seen increased growth in STEM occupations, specifically in mathematics, science, and computer science fields of expertise (Fayer et al., 2017; Noonan, 2017). Basic and applied research in areas of STEM and workforce occupations are a priority for future workforce planning and shaping (Borgerding, 2015; Le & Robbins, 2016). While the technical proficiency gap is widening for STEM occupations and STEM job demand is increasing, many scientists and engineers are entering retirement across the federal government in large numbers (Fayer et al., 2017; Noonan, 2017). The STEM occupation need has led to the beginning stages of a STEM workforce crisis, as well as a skillset and knowledge gap between generations in the federal government agencies (Fayer et al., 2017; Noonan, 2017).

There are increasing academic performance gaps among African American/Blacks and Latinos/Hispanics who lag behind in mathematics, science, and computer science compared to their Asian and White counterparts (Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017). The generational knowledge divide exists across numerous STEM fields but is particularly alarming in the mathematics, science, and computer science (see a list of STEM fields and STEM-related fields in Appendix A). The divide is due to the low achievement scores, including advanced academic placement (AAP), found in critical junctions that affect underrepresented minorities (URM) and low-socioeconomic status (SES) that face economically disadvantaged circumstances (Carnevale, Cheah & Hanson, 2015; Schleicher, 2017). Low-socioeconomic status (SES) groups were pre-defined in this study as a composite variable collected from the education data analysis tool (EDAT) used to measure SES status calculated using parent/guardians' education, parent/guardians' occupation, and family income. Low academic achievement among URMs and low-SES, specifically students in Title 1 schools, were found to have a significant drop in mathematics academic performance of which are highly diverse student populations and will comprise the majority of the next generation workforce (Bohrnstedt et al., 2015; Kastberg, Ying Chan, & Murray, 2016; Olszewski-Kubilius et al., 2017; Provansnik et al., 2016, Schleicher, 2017). As the knowledge gap increases across generations and proves to be a pervasive problem, federal and industry professionals will have to understand academic barriers early in secondary school and plan for future career pathways to gain a high probability of success for recruitment and retention as viable options into STEM fields (Negru-Subtirica & Pop, 2016).

Recruitment, retention, and education outreach in STEM programs serve as a bridge to engage the next generation to consider employment in the federal government or industry through a sponsored program (Borgerding, 2015; Le & Robbins, 2016). Desired STEM workforce outcomes are effectively attained through custom minority-focused outreach initiatives design by understanding the target feeder population into the workforce, which are minority and low-SES high school students (Andrews & Stange, 2016; Carnevale et al., 2015; Olszewski-Kubilius et al., 2017). Future workforce planning initiatives established by industry and the government aim to ensure the youth are college ready and workforce ready (Stephens, Hamedani, & Destin, 2014; Wang, 2013; Wong, Wan, & Gao, 2017). Multiple research sources recommend establishing outreach programs focused on STEM and the inclusion of URMs and low-SES groups for earlier engagement to reach populations of interest including minority demographic groups effectively through customized approaches (Stephens, Hamedani, & Destin, 2014; Wang, 2013; Wong, Wan, & Gao, 2017).

Student performance in STEM education in combined URMs and low-SES groups compared to peer majority groups revealed barriers to entry at critical junctures including high school graduation and transition to college. The student performance is related to the level of STEM courses taken during postsecondary school (Black, Lincove, Cullinane, & Veron, 2015; Bohrnstedt et al., 2015; Kastberg et al., 2016; Schleicher, 2017). Low-SES is overrepresented by minority population, specifically from African American/Black and Latino/Hispanic populations (Jones et al., 2018; Kastberg et al., 2016; Lauen, & Gaddis, 2013). Students in combined URMs and low-SES groups experienced barriers at the critical education junctures which created ripple effects impacting long-term effects on workforce outcomes in a STEM career field. Furthermore, URMs are particularly who were projected to encompass larger proportions of the U.S. population in the future years and provide an untapped talent pool at the time of this study (Bohrnstedt et al., 2015; Borgerding, 2015; Fayer et al., 2017; Le & Robbins, 2016).

The U.S. nation's minority youth will lack the education knowledge base required to successfully transition into young adulthood without a strong STEM education in secondary school, which will require remediate education and training to overcome the gap between non-URM colleagues to attain STEM degrees and STEM occupations (Carnevale et al., 2015; Houston & Yonghong, 2016; Latterell & Wilson, 2013). Non-underrepresented minorities (non-URMS) are defined in this study as member's race/ethnicity characterized by two dichotomous composite variables which include the following demographics: *White*-composite or *Asian*-composite *(including Chinese, Filipino, Korean, Japanese, Southeast Asian such as Vietnamese or Thai, South Asian such as Asian Indian or Sri Lankan)*. Academia, industry, and government have recognized this need for remedial training (Logue, Watanabe-Rose & Douglas, 2016; Noonan, 2017). Additionally, both industry and government face a technical workforce shortage with an unbalanced demographic population pipeline in STEM fields that are quantified and monitored through communities of interests, federal interagency working groups, and ongoing workforce analyses projections (Kastberg et al., 2016; Noonan, 2017). Both industry and government have funded STEM education and outreach initiative investments to address this national issue (Borgerding, 2015; Wei, 2014). Therefore, this quantitative research contributed to the body of research on STEM education through a quantitative causal-comparative (ex-post facto) quasi-experimental methodology to address the minority and low-SES academic barriers.

Assessment of self-efficacy dovetailed with the STEM AAP proficiency shortfalls that occurred during secondary school and through critical junctures into higher education, including STEM career decisions, helps determine solutions to engage URMs and low-SES populations through Federal STEM programs and policy change recommendations (Blustein et al., 2013; Bottia, Stearns, Mickelson, Moller & Parker, 2015; Kettler & Hurst, 2017). Academic achievement, education choices, and career choices become vital areas to assess for the URM population as they rise to the majority in the near future. Ensuring minorities receive access to opportunity is vital for U.S. industry and government to meet the long-term employment needs required to defend the nation and remain globally competitive. Studies suggest that there is a recognized unbalanced demographic pipeline within the government and industry that needs to be addressed through earlier engagement of youth in STEM especially near critical junctures, such as high school in STEM education, to improve sustainable influence in education development and career pathing for URMs and low-SES in STEM education and workforce career pathing (Carnevale et al., 2015; Wang, 2013; Wong et al., 2017).

Statement of the Problem

The general problem was there is a lower amount of youth URMs proficient in STEM who are prepared to enter STEM professions compared to Asian and White (non-URMs) peers, thus resulting in future workforce talent shortages in the U.S. (Cannady, Greenwald & Harris, 2014; Noonan, 2017; Sadler et al., 2014). Minority young adults' knowledge in science, mathematics, and computer science academic outcomes are significantly less proficient than their Asian and Caucasian/White counterparts (Hall, Nishina & Lewis, 2017; Voight, Hanson, O'Malley & Adekanye, 2015). The specific problem was that minority's high school youth, who are largely in low-SES groups, lack student proficiency and self-efficacy in STEM AAP courses (Lian, 2017; Martinez & Guzman, 2013). The STEM knowledge gap between low-SES URMs and non-URMs influence critical junctures in high school education and creates barriers linked to student decisions caused by the lack of self-efficacy (Dou & Gibbs, 2013; Hwang, Choi, Lee, Culver & Hutchison, 2016; Lauen & Gaddis, 2013; Miller-Cotto & Byrnes, 2016). As such, the lack of minorities youth self-efficacy in STEM impacts the U.S. need for agile talent with proficiency in science, mathematics, and computer science skills (Fayer et al., 2017; Latterell & Wilson, 2013; Noonan, 2017; Redmond-Sanogo et al., 2016).

Andrzejewski, Davis, Shalter Bruening, and Poirier (2016) conducted a study which indicated self-regulated learning for low-income and minority students. The study did not provide a successful intervention to close the achievement gap in STEM proficiency. Furthermore, gaps in research show a small number of studies have investigated barriers linked to minority and poverty with regard to resource scarcity preventing academic achievement and limit opportunities (Papadimitriou, 2014; Smith, 2016; Steele, 2016). This study and future studies will contribute to the field of education by providing insight to how the self-efficacy of URMs, including low-SES high school students, impacts STEM education outcomes.

Purpose of the Study

The purpose of this quantitative, causal-comparative (ex-post facto) quasi-experimental study was to examine the difference in self-efficacy and STEM education outcomes between URMs and non-URMs (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). The predictor variables will be URMs, to include participants who are African American/Black and Latino/Hispanic, including participants from low-SES, and non-URMs. The non-URM population sample will include participants who are Caucasian/White and Asian. Multiple outcome variables will be measured for assessing self-efficacy and STEM education outcomes. Self-efficacy variables include a separate composite metric scale for a student's mathematics self-efficacy and science self-efficacy of which student self-belief, self-regulation, self-evaluation, self-stimulation, and self-monitoring of mathematics and science was measured for students who provided a full set of responses in the NCES HSLS:09 survey (Arlsan, 2016; Sen, 2016).

The STEM education outcome variables include mathematics, science, and computer science AAP test scores, computer science AAP test scores. The mathematics AAP test scores include *Mathematics and Computer Science*, *Calculus AB*, and *Calculus BC*. The science AAP test scores include *Biology*, *Environmental Science*, *Chemistry*, *Physics B*, and *Physics C*. The computer science AAP test scores will be measured using the *Computer Science A* test scores. The research method includes a secondary analysis of quantifiable nationally representative high school-age education dataset that the U.S. Department of Education compiled for the school year

2009-2012 during a longitudinal study while mapping postsecondary routes that students embarked.

The dataset was obtained through survey data collected from the High School Longitudinal Study of 2009 (HSLS:09) using the education data analysis tool [EDAT], from the Institute of Education Sciences (IES) at the National Center for Education Statistics (NCES) data center. The HSLS:09 dataset included over 23,000 students from 944 schools, with two follow-up datasets that occurred in 2012 and 2016 (NCES, 2018). The sample population includes over 8,000 high school students from 2009 through 2016 across four demographic groups, including low-SES. The EDAT was utilized to evaluate and measure content comprehensiveness of academic performance scores and self-efficacy scales across the comparison sample groups through linear regression data analysis using the Statistical Package for the Social Sciences (SPSS) software to determine the extent of the relationships between URMs and non-URMs with regard to the predictive value of the difference between self-efficacy and STEM education outcomes (Field, 2013). A descriptive statistical analysis will be performed, and hierarchical linear modeling will be utilized to test the null hypothesis and alternative model of this study. The results of the study may build upon the past research of STEM diversity education programs, and integration of the minority population and low-SES groups into the next generation of future scientists and engineers to ensure youth are college ready and Federal workforce ready (Wang, 2013; Wong et al., 2017).

Theoretical Framework

The customized theoretical framework, depicted in Figure 1, was developed to structure the research while maintaining a foundation in theory grounded in student self-efficacy and STEM Education outcomes (Halim, Abd Rahman, Zamri, & Mohtar, 2017; Hall et al., 2017;

Latterell & Wilson, 2013; Papadimitriou, 2014). For this study, an appropriate theoretical framework, was based on Self-Determination Theory (SDT) and Social Cognitive Career Theory (SCCT) to provide the framework for support of student interest in STEM education and careers through fostering strong self-efficacy in STEM advanced academic courses (Deci & Ryan, 1985; Lent, Brown, and Hackett, 1994; Salkind, 2010). The core components of SCCT included an interplay of the following (a) personal attributes (e.g., self-efficacy and race), (b) external environmental factors (e.g., educational opportunities and socioeconomic status) and (c) overt behaviors (e.g., course selection and past experience) of which all lead to career-related outcomes. The SCCT claimed that career field choice is greatly influenced by career field interest. Moreover, career choice behavior and career field interest were largely impacted by career self-efficacy which were deeply embedded in academic course instructions and STEM outreach engagement (Lent & Brown, 1996). Lent et al., (1994) indicated that career-related self-efficacy can be increased through effective experiences focused on career-related tasks which begins with early intervention in youth academia.

The current study was designed to compare the difference between URMs and non-URMs, including low-SES, level of self-efficacy and participation in advanced academic courses in mathematics, science and computer science subjects to gain insight for ways to increase positive attitudes toward STEM education and careers for high school students. The results of this study expanded the current body of minority, low-SES and advanced academic achievement research by adding self-efficacy and career development theory implications for the high school student population. Finally, this study added to the current education body of research with the SSCT variables of STEM career interest and self-efficacy for high school students, minorities, and low-SES. The theoretical framework focused on four categories of variables at the individual student-level, provided the quantitative purpose for capturing the diversity perspective on STEM education as it related to self-efficacy among youth leading to U.S. STEM jobs (Dou & Gibbs, 2013; Lian, 2017; Wang, 2013; Wang & Degol; 2013).

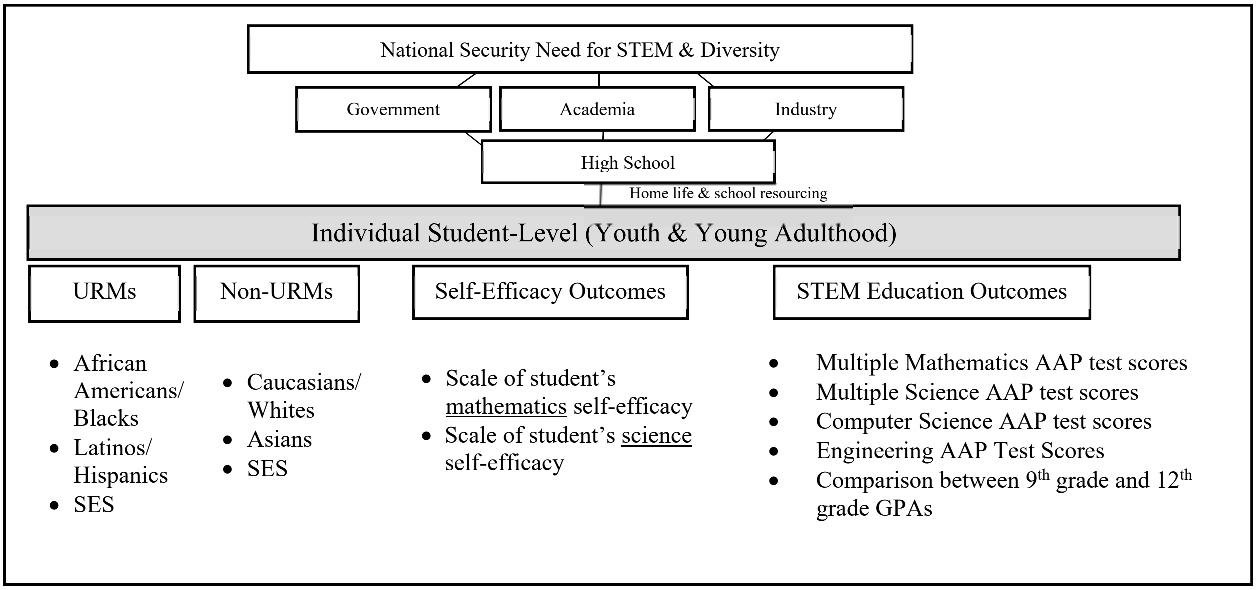

Figure 1 Theoretical Framework for National Security for STEM & Diversity Based on Academic Achievement in Mathematics & Science.

Nature of the Study

A quantitative research method was used for this study with a causal-comparative (ex-post facto) quasi-experimental design to determine between URMs and non-URMs with regard to the relationship between self-efficacy and STEM education outcomes of youth in U.S. public schools. Quantitative research was chosen due to the systematic nature of the approach and ability to determine relationships between variables for sample population identification (Muijs, 2011; Salkind, 2010; Vogt, 2006). Quantitative research methods are more appropriate studies observing characteristics of groups because the data was used to identify possible causal relationships between variable impacts based on the archival data containing AAP test scores to clarify prediction of URM and non-URM performance in relation to self-efficacy (Cook & Cook, 2008; Teo; 2013).

A cross-sectional design was selected using matched comparison groups since the data involved naturally created groups with data collected at a single point in time used to address the research questions (Salkind, 2010). This research design was appropriate because it examined if the differences existed in student achievement of student groups based on selected comparison variables and observed characteristics to construct a comparison group using statistical techniques with demographic variables through an archival focused comparison research approach (Asamoah, 2014; Klugh, 2013; Salkind, 2010; Vogt, 2006, Vogt et al., 2012). In a causal-comparative inquiry, the researcher does not have the ability to control for extraneous or external variables (Kraska, 2010). The study was designed to collect and analyze multiple self-efficacy and STEM education outcomes variables while focusing on the following specific criterion variables: (a) scale of student's mathematics self-efficacy, (b) scale of student's science self-efficacy, (c) *Calculus AB* test scores, (d) *Calculus BC* scores, (e) *Statistics* scores, (f) *Biology* scores, (g) *Environmental Science* scores, (h) *Physics B* scores, (i) *Physics C scores*, (j) *Chemistry* scores, or (k) *Computer science A* scores. The predictor variables included URMs and non-URMs, including low-SES, of which the specific variables included: (a) African American/Black participants, (b) Latino/Hispanic participants, (c) Caucasian/White participants, (d) Asian participants, and (e) low-SES participants (Bohrnstedt et al., 2015; NCES, 2015). Using this design, original archival records were extracted to seek primary and secondary research through coding, analyzing the data through summaries and inferences, and organizing the information to inform actionable recommendations for policy changes to address the national security issues facing education that were linked to the technical workforce (Cook & Cook, 2008; Redmond-Sanogo et al., 2016; Vogt, 2006).

The quantitative comparison design methodology allows for analysis of the population data through review of the individual achievement gap using NCES national data (NCES, 2015). Data collected was recently published by the Department of Education and provides detailed records capturing longitudinal records on U.S. students from ninth-, tenth-, eleventh-, and twelfth-grade as well as data on schools, colleges, teachers, parents, enrollment, test scores, post-graduates, educational attainment, finances and career counselors (Bohrnstedt et al., 2015; Kastberg et al., 2016). Data collection involved gathering the archival data from the EDAT national database containing AAP test score data from the High School Longitudinal Study of 2009 that encompasses over 21,000 pieces of data (NCES, 2015). The validation process included over 8,000 sets of data to work with grounded in an empirical analysis using Classical Test Theory coupled in the national database to evaluate the psychometric properties of each item throughout the archival data analysis (NCES, 2015). Data analysis included multivariate analysis of variance (MANOVA) using the Statistical Package for the Social Sciences (SPSS) software to determine the extent of the relationships between and predictive value of the multiple criterion variables (self-efficacy and STEM education outcomes), and the predictor variables (URMs and non-URMs) (Field, 2013). Additional data analytics and technical notes can be found in Appendix B.

Research Question

RQ1. What is the difference in self-efficacy and STEM education outcomes between URMs and non-URMs?

RQ1.a. What is the difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs?

RQ1.b. What is the difference in self-efficacy and science AAP test scores between URMs and non-URMs?

RQ1.c. What is the difference in self-efficacy and computer science AAP test scores between URMs and non-URMs?

Hypotheses

$H1_0$. There is not a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1_a$. There is a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1a_0$. There is not a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1a_a$. There is a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1b_0$. There is not a statistically significant difference in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1b_a$. There is a statistically significant difference found in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1c_0$. There is not a statistically significant difference in self-efficacy and computer science AAP test scores between URMs and non-URMs.

$H1c_a$. There is a statistically significant difference found in self-efficacy and computer science AAP test scores between URMs and non-URMs.

Significance of the Study

This study was significant considering the academic achievement gap among URMs and non-URMs and the impending STEM workforce crisis that is growing as STEM occupations continue to rise at above-average rates while the minority population is projected to become the majority of the U.S. workforce over the next decade (Castleman et al., 2018; Fayer et al., 2017; Noonan, 2017; Olszewski-Kubilius et al., 2017). There were overwhelming academic achievement gaps found across minority groups and low-income student groups in all stages of the education pipeline, specifically in mathematics, that feed into the labor workforce pipeline that must be addressed to ensure the nation's future force will have the STEM competencies and skills for tomorrow's jobs (Fayer et al., 2017; Noonan, 2017; Olszewski-Kubilius et al., 2017). Moreover, STEM competencies required for the future workforce extend beyond the traditional STEM occupations (Cannady, Greenwald & Harris, 2014; Fayer et al., 2017; Noonan, 2017). The government's defense agencies recognize how vital STEM competencies are to its mission and may need to change how diversity STEM engagement strategies are managed to ensure the education pipeline is primed appropriately with a strong foundation in mathematics and science (Cannady, Greenwald & Harris, 2014; Fayer et al., 2017; Noonan, 2017).

The Federal STEM strategy on youth engagement must be evaluated and redesigned, as applicable. The government reaches into communities with Federally-funded education programs to connect youth and their families with achievable dreams for their future built on trust and in partnership with the government in education programs that work for local communities (Castleman et al., 2018; Papadimitriou, 2014). Additionally, with insufficient resources, scarcity of food (such as school's on the nation's lunch program), and a home-environment that is unproductive to learning, many students in poverty have a significant disadvantage that creates a vast unbalance with regard to academic performance amongst their peers (Stephens et al., 2014; Lauen & Gaddis, 2013). The majority of students in poverty in twelfth grade in mathematics were in the African American/Black, Latino/Hispanic and American Indian demographic population groups (Kastberg et al., 2016).

Definitions of Key Terms

Diversity. *Diversity* was the different attributes, traits, or characteristics of individuals or groups of individuals (Hall et al., 2017; Miller-Cotto & Byrnes, 2016).

Scientists and Engineers. Scientists and engineers were as the workforce of individuals who have ever received a U.S. bachelor's or higher degree in a science and engineering (S&E) field or S&E-related field or individuals holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation (National Center for Science and Engineering Statistics, 2012).

Science, Technology, Engineering and Mathematics (STEM). *Science, Technology, Engineering, and Mathematics (STEM)* was a single acronym used to define multiple disciplines for education literacy and future workforce needs. For the purpose of this quantitative study, STEM literacy was defined as the ability to recognize, analyze, and interweave science, technology, engineering and mathematics concepts to understand complicated problems and deliver innovative solutions with the purposeful identify fulfillment that can be repeatable and sustainable (McDonald, 2016).

STEM Activities, Programs or Investments. *Science, Technology, Engineering, and Mathematics (STEM) Activities, Programs or Investments* are a program, initiative, or activity for which the primary mission is: (a) to attract and prepare learners to pursue classes or coursework in STEM areas; (b) improve the capacity of teachers and institutions to promote and foster learning in STEM fields; (c) train employees in tradecraft associated with STEM; and (c) outfit and sustain STEM facilities Activities include processes comprised of monitoring, experimentation, study, research, designing, modeling, and scientific and engineering assessments (McDonald, 2016; Somsak & Prachyanun, 2016).

STEM Occupations. Occupations in STEM included computer and mathematical scientists; biological, agricultural, and other life scientists; physical and related scientists; social and related scientists; and engineers as defined by the National Science Foundation in the National Center for Science and Engineering Statistics (2012). Related occupations in STEM include health-related occupations, S&E managers, S&E precollege teachers, S&E technicians and technologists, and other S&E-related occupations, such as architects and actuaries (National Center for Science and Engineering Statistics, 2012).

STEM Outreach. *Science, Technology, Engineering, and Mathematics (STEM) Outreach* efforts to inspire, strengthen, inform, promote and engage others through building awareness, developing relationships, and promoting opportunities, activities, and products across all stages of the learning continuum through formal and informal means (McDonald, 2016; Somsak & Prachyanun, 2016).

STEM Workforce Development. *Science, Technology, Engineering, and Mathematics (STEM) Workforce Development* was the process of providing instruction and applied exercises for acquiring and retaining skills, knowledge, and competencies in the fields considered within science, technology, engineering and mathematics in the Federal government (Fayer et al., 2017; Noonan, 2017).

STEM Education. *Science, Technology, Engineering, and Mathematics (STEM) Education* was the process of providing information via formal and informal instruction and applied exercises, including STEM content research. Research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts in any of the STEM fields (McDonald, 2016; Somsak & Prachyanun, 2016).

STEM Proficiency. *Science, Technology, Engineering, and Mathematics (STEM) Proficiency* was the knowledge and understanding of STEM concepts and processes required to perform in a technical work (McDonald, 2016; Somsak & Prachyanun, 2016).

Student Self-Efficacy in Mathematics and Science. *Self-Efficacy in Mathematics and Science* were measured by each mathematics and science, separately, using the HSLS:09 survey questions to retrieve the self-efficacy variable as a single scale number that represents a higher mathematics or science-specific self-efficacy factors of an individual based on a compilation of multiple principal components factor analyses of which the Department of Education conducted to generate the self-efficacy scale score. Additional details regarding the measurements of the student self-efficacy can be found in Appendix C.

Underrepresented Minorities (URMs) in STEM. *Underrepresented Minorities (URMs) in Science, Technology, Engineering, and Mathematics (STEM)* were the low- and moderate-income populations, communities of color, youth, women, and other populations that are traditionally underserved or underrepresented in STEM fields (Ellis, Fosdick & Rasmussen, 2016; Hall et al., 2017; Miller-Cotto & Byrnes, 2016).

Summary

Research in the STEM academic achievement gap between URMs and non-URMs, including low-SES, high school student populations can reveal indicators of demographic force-shaping initiatives to meet government and industry STEM education and workforce recruitment needs (Fayer et al., 2017; Noonan, 2017). The problem that was addressed in this study was that there was a lower amount of youth URMs proficient in STEM who were prepared to enter STEM professions compared to Asian and Caucasian/White (non-URMs) peers, specifically minority's high school youth who were largely in low-SES groups lack student proficiency and self-efficacy in STEM AAP courses (Cannady, Greenwald & Harris, 2014; Lian, 2017; Martinez & Guzman, 2013; Noonan, 2017; Sadler et al., 2014). The purpose of this quantitative study, utilizing a comparison research design, was to examine the difference in self-efficacy and STEM advanced academic between URMs and non-URMs with regard to the relationship between performance in high school education through the a national perspective theoretical framework (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). This study utilized a quantitative causal-comparative (ex-post facto) quasi-experimental design with matched comparison groups to address the research questions. A quantitative research design was deemed appropriate because of the ability to (a) determine relationships between variables for sample population identification and (b) observe characteristics through constructing a comparison group using statistical techniques with demographic variables (Asamoah, 2014; Klugh, 2013; Muijs, 2011; Vogt, 2006, Vogt et al., 2012). The predictor variables were URMs, to include participants who were African American/Black and Latino/Hispanic, including participants from low-SES, and non-URMs of which include participants who were Caucasian/White and Asian (Bohrnstedt et al., 2015; NCES, 2015). Outcome variables included self-efficacy and STEM education outcomes.

Chapter 1 began with an overview of the introduction, background, problem statement, and purpose statement. The purpose statement was followed by the theoretical framework, nature of the study, significance of the study, definitions of key terms, and a summary. Chapter 2 provides the literature review for the study as it relates to the dependent and independent variables.

Chapter 3 provides the research methodology that guides this research study. In the remaining chapters, chapter 4 details the findings, chapter 5 presents the results, and chapter 6 provides the discussion.

Chapter 2: Literature Review

The examination of the differences in self-efficacy and STEM education outcomes between underrepresented minorities (URMs) and non-URMs performance in high school education through a quantitative, causal-comparative (ex-post facto) quasi-experimental study can provide insight into STEM workforce planning needs (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). Proficiency in science, technology, engineering, and mathematics (STEM) education is required to successfully complete high school, transition into higher education, and enter careers to meet Defense national security challenges (Cannady, Greenwald & Harris, 2014; Sadler, Sonnert, Hazari & Tai, 2014). However, the increased demand for a diverse STEM talent pool requires investments in education to build the future potential talent pool. The fastest growing occupations in the U.S. are in STEM fields, but government and multiple industry sectors have historically struggled with filling top intellect from URM groups in high demand STEM occupations (Fayer, Lacey, & Watson, 2017; Hall, Nishina & Lewis, 2017; Noonan, 2017; Wang & Degol, 2013).

Researchers across numerous literature sources frequently often concentrated on areas of low-academic achievement in STEM among URMs who were largely in low-SES groups and a high school advanced academic placement (AAP), and self-efficacy to address the problem of this study (Cannady, Greenwald & Harris, 2014; Lian, 2017; Martinez & Guzman, 2013; Noonan, 2017; Sadler et al., 2014). The first two sections of the literature review focused on the holistic importance of STEM occupations in government, academia, and industry and address the critical juncture in high school as the background for justifying the national security workforce issues address in this study. The second, third, and fourth sections of the literature review focused on the central purpose of the study, achievement gaps in STEM education, student self-efficacy, and socioeconomic status in education. Each section examined the literature and combined multiple topics to differentiate academic disparity across demographic groups as it related to specific literature topics. Additionally, curriculum effectiveness, engagement of URMs, and self-efficacy in STEM were each addressed in literature reviews by cluster reviews of grouping by similarity or paradoxes. Finally, the last section addressed the federal policies to support STEM education programs for students from URM or low-SES demographics.

Documentation

Peer-reviewed research articles were the main sources of documentation. The databases primarily accessed for documentation gathering were retrieved from the Northcentral University library to locate both seminal and pertinent research. The research article process began with keyword searches using the following databases: EBSCOhost, Ebrary, ERIC, Google Scholar, ProQuest, and Science Direct. Alternate data mining and searching techniques were utilized by assembling the keywords in different ways related to the literature review to identify current or similar research studies. In addition, peer-reviewed journal references were also extracted and examined for relevance to the current study conducted. Some of the key words included: science, mathematics, engineering, education, advanced academic placement, STEM education, student engagement, low-socioeconomic status in STEM and minorities, Black/African American and STEM education, Hispanic/Latino and STEM education, education for sustainable development, high school students, self-efficacy, underrepresented minorities, diversity in STEM, diversity outreach, and STEM education outcomes.

Themes quickly emerged on a repetitive basis during the literature review. Three common themes emerged. *Theme A* involved the relationship between academic achievement of minority students and enrollment in critical STEM courses that provide a strong foundation for college preparedness and achievement (Alvarado & An, 2015; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Bryan, Glynn, & Kittleson, 2011; Martinez & Guzman, 2013; Miller-Cotto, & Byrnes, 2016; Negru-Subtirica & Pop, 2016; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Sadler, Sonnert, Hazari & Tai, 2014; Stipanovic & Woo, 2017). *Theme B* revealed that mathematics and science advanced academic placement preparation linked to self-efficacy and postsecondary education and career attainment (Ackerman, Kanfer & Calderwood, 2013; Astin & Oseguera, 2012; Dyce, Albold, & Long, 2013; Hwang, Choi, Lee, Culver & Hutchison, 2016; Konstantopoulos, 2006; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Sen, 2016; Shaw, Marini & Mattern, 2012; Wang, 2013; Wang & Degol, 2013). *Theme C* uncovered that lower SES levels can limit the education opportunities available and provide inequality in secondary education for some students because of the scarcity of resources which can have a large effect on African American and Hispanic/Latino students, as those students are in URM groups of which students from URMs come from the highest percentage of the U.S. low-SES population (Andersen & Ward, 2014; Andrews & Stange, 2016; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Carnevale, Cheah & Hanson, 2015; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Stephens, Hamedani, & Destin, 2014; Suziedelyte & Zhu, 2015). A diagram of the three common emerging themes aligned with the literature review of the categorical themes which includes two additional theme areas of STEM jobs and Federal STEM initiatives, shown in

Figure 1, of which aligns to the literature of the overarching STEM education disparity problem addressed throughout this study to assist in the solution for resolving the future STEM workforce diversity gap issue (Brown, 2016; U.S. Bureau of Labor Statistics, 2016; U.S. Bureau of Labor Statistics, 2017).

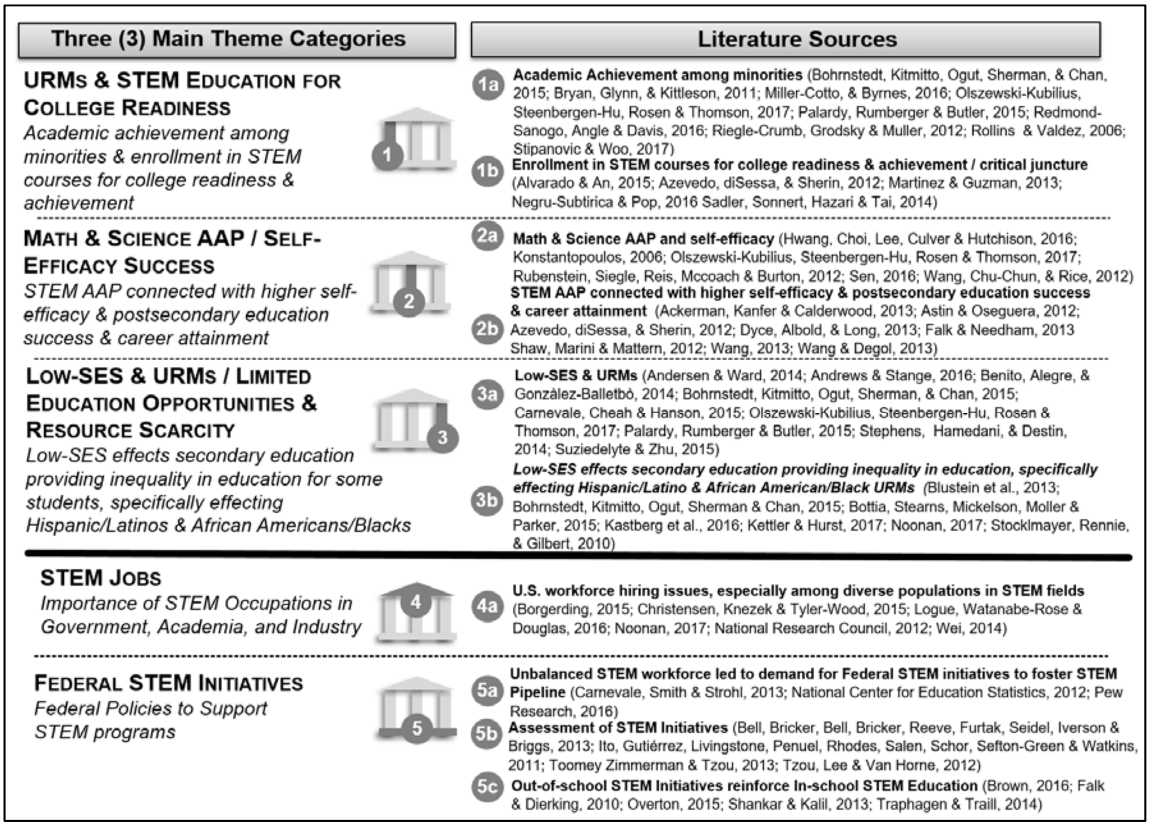

Figure 2. Three Common Emerging Themes in Alignment with the Key Literature Sources Organized by Categorical Topic Areas.

Education Disparity Theoretical Framework

From the early 1990s to the present day, the education disparity has continued to grow wider between URMs and non-URMs in the STEM fields which may be linked to the socioeconomic status composite of the schools, diversity demographics of schools, quality of effective teachers, and advanced academic placement STEM courses available at schools (Blustein et al., 2013; Bohrnstedt, Kitmitto, Ogut, Sherman & Chan, 2015; Bottia, Stearns, Mickelson, Moller & Parker, 2015; Kastberg et al., 2016; Kettler & Hurst, 2017; Noonan, 2017).

Available data confirms the imminent workforce hiring issues, especially among diverse populations in STEM fields (Borgerding, 2015; Christensen, Knezek & Tyler-Wood, 2015; Logue, Watanabe-Rose & Douglas, 2016; Noonan, 2017; Wei, 2014). As of 2018, STEM professions continue to rapidly rise; however, many students who are in the African American/Black and Latino/Hispanic URM population groups are lagging behind their peers and this growing demand for STEM competencies cannot be met without understanding the diversity issues residing in STEM education, including an unbalanced demographic workforce that were predominantly male and Caucasian/White or Asian (Carnevale, Smith & Strohl, 2013; National Center for Education Statistics, 2012; Pew Research, 2016). A graphical image of the U.S. workforce pipeline representing the in-school and out-of-school STEM exposure for students, shown in Figure 2, demonstrates that in the early education years of a student's education there were a higher number of students available for impact due to enrollment rates in schools, and as a student progresses through the education pipeline the impact becomes deeper and more targeted departing the interest stages and short-duration events, while entering into the enrichment and employment stages with internships and longer durations of interactions with mentors in STEM activities of which all address the individualized approaches needed to move the needle forward with regard to academic disparity among URM and low-SES populations groups (Ackerman, Kanfer & Calderwood, 2013; Astin & Oseguera, 2012; Azevedo, diSessa, & Sherin, 2012; Bell, Bricker, Bell, Bricker, Reeve, Falk & Dierking, 2010; Brown, 2016; Duodu, Noble, Yusuf, Garay & Bean, 2017; Dyce, Albold, & Long, 2013; Falk & Needham, 2013; Furtak, Seidel, Iverson & Briggs, 2013; Ito, Gutiérrez, Livingstone, Penuel, Rhodes, Salen, Schor, Sefton-Green & Watkins, 2011; Overton, 2015; Shaw, Marini & Mattern, 2012; Shankar

& Kalil, 2013; Toomey Zimmerman & Tzou, 2013; Traphagen & Traill, 2014; Tzou, Lee & Van Horne, 2012; Wang, 2013; Wang & Degol, 2013;).

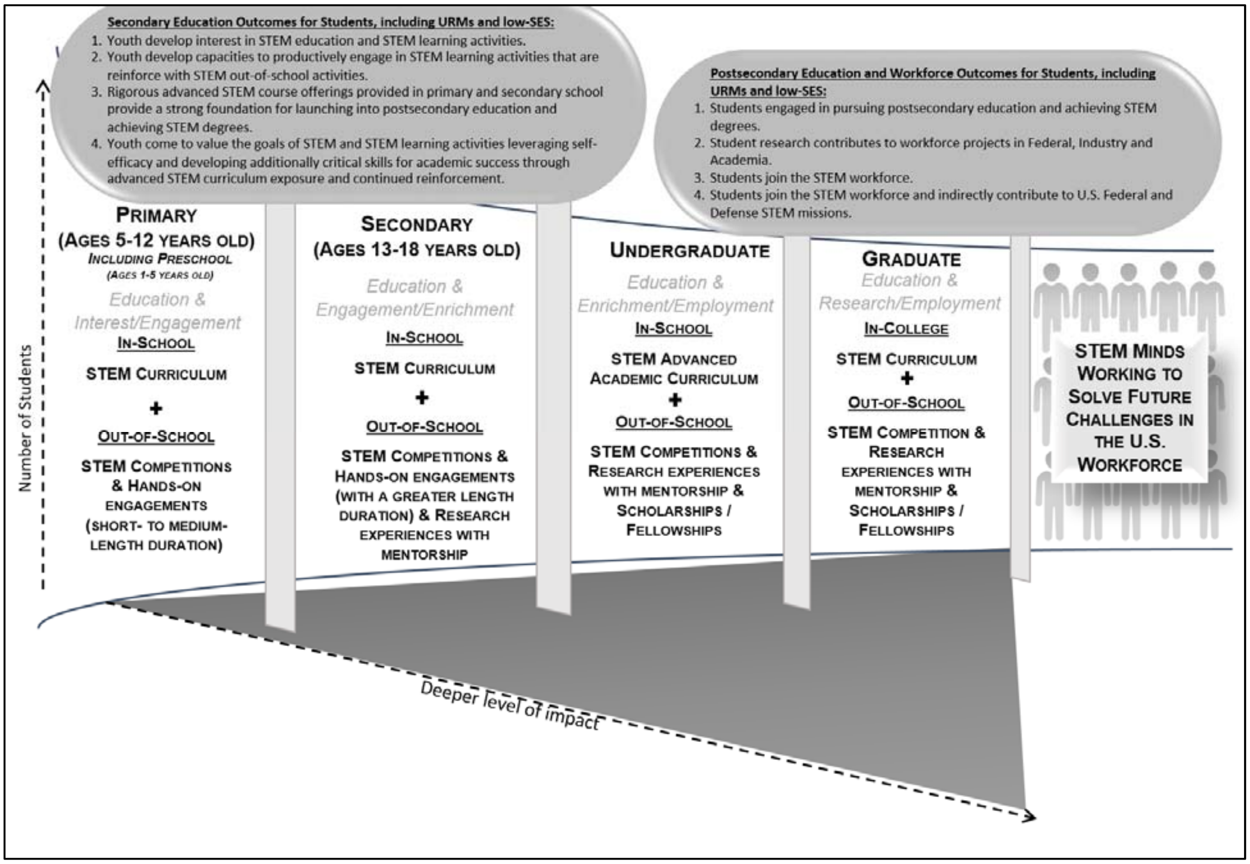

Figure 3. A Graphical Representation of the U.S. Workforce Pipeline for In- and Out-of-School STEM Exposure for Students Depicting a Deeper Level of Exposure to Fewer Number of Students as the Education Pipeline approaches entering the Workforce.

Importance of STEM Occupations in Government, Academia, and Industry. Across all markets within government, academic, and industry, there is an emphasis placed on technological importance across all occupations resulting in general STEM competencies becoming a foundation for many non-STEM occupations (Gottron, 2017; Tehan, 2017). In elementary and secondary school, research shows that student motivational profiles can significantly impact a student's decision to pursue college or a STEM career, and are characterized by a focus on learning and understanding, value for coursework, and high confidence in a student's abilities to accurately complete the coursework are associated with higher levels of education engagement and achievement in mathematics coursework (Chapman, 1981; Linnenbrink-Garcia et al., 2018). In postsecondary education, research shows that student motivational profiles are characterized by the following two indicators: the completion of STEM coursework, and a student's intentions to pursue a science career (Linnenbrink-Garcia et al., 2018). A research study conducted by Linnenbrink-Garcia (2018) investigated how motivational beliefs adhere and function with one another, such as motivational profiles, and to determine academic change. The results found three collective patterns of motivation (*moderate-high all, intrinsic and confident*, and *average all*) were identified across a sample of elementary through college students in science fields of study with one distinctive pattern identified in each sample that included *very high all* for the elementary students only, and *moderate intrinsic and confident* for the college students only (Linnenbrink-Garcia et al., 2018). In contrast, profiles characterized by more moderate levels of motivation had the lowest levels of academic engagement, achievement, and persistence. Moreover, the results of the study highlighted the importance of building educational frameworks that support goals to develop, learn, and maintain a student's value for pursuit of education or a specific field of study, to include development in self-efficacy of self-confidence in the student's ability to gain knowledge through learning (Linnenbrink-Garcia et al., 2018). Gaps between STEM education and required workplace occupation skills have been identified in government, academia, and industry (Jang, 2016).

Jang (2016) conducted an analysis of the importance of 109 types of knowledge, skills, and work activities using Katz and Kahn (1978) framework while testing for inter-rater reliability to identify how many competencies and which ones were important for STEM workers. A comparison analysis was conducted using participants in current STEM occupations in one group and participants in non-STEM occupations for the second group to investigate the importance of job skills. The researchers found that 7 categories of knowledge, 18 skills, and 27 work activities were important for workers STEM occupations (Jang, 2016). Additionally, the findings show that current education frameworks for 21st century skills and engineering education do not cover all important STEM competencies required for STEM occupations that are important to government, academia and industry (Jang, 2016).

National security workforce in STEM diversity gap. The U.S. civilian labor force is projected to reach 169.7 million by 2026, with an annual growth rate of 0.6 percent of which is slower than the annual growth experienced during several preceding decades (U.S. Bureau of Labor Statistics, 2017; Vilorio, 2014). According to the U.S. Bureau of Labor Statistics (2017), the labor force will continue to change in racial and ethnic composition because segments of the population that originate from Asian and Hispanic/Latino demographic groups are expected to grow at faster rates than the average annual rate from 2016 to 2026 (2.5 percent and 2.7 percent, respectively). Furthermore, in 2026, 20 percent of the labor force is projected to be comprised of employees with an origin from the Hispanic/Latino population (U.S. Bureau of Labor Statistics, 2017). The slow labor force growth can be attributed to gradual decline from 1996 to current state which led to a trend in a decelerating growth of the civilian labor market. Additionally, as the large labor force begins to enter retirement, the U.S. Bureau of Labor Statistics (2017) projects a decrease in the overall workforce from 62.8 percent in 2016 to 61 percent in 2026. The peak labor workforce staffing was 67.1 percent in 2000 (U.S. Bureau of Labor Statistics, 2017).

As the labor market demographics shift to become a majority diverse workforce, the scientific and technical occupation gap in diversity talent will become a national security concern (U.S. Bureau of Labor Statistics, 2017; Vilorio, 2014). Occupations in STEM across the Federal government, industry and academia provide higher earnings than the U.S. average occupation and typically require a postsecondary STEM education (Cover, Jones, & Watson, 2011; Vilorio, 2014). Enrollment rates in U.S. postsecondary education may seem acceptable typically around 65 percent; however, the conferred degrees for STEM fields is low. According to the U.S. Bureau of Labor Statistics (2017), only 8 percent of all graduates in 2016 conferred degrees in Natural Sciences, Mathematics, Computer Science, and Engineering in the U.S. and a small segment of the 8 percent were URMs.

Historically, the education pipeline has been the responsibility of secondary and postsecondary education systems to foster and maintain a healthy output of students into STEM fields to meet the workforce and academia demand. Researchers have investigated the U.S. workforce hiring issues, especially among diverse populations in STEM fields and found that numerous federal agencies and organizations have developed customized STEM initiatives to meet mission needs and develop while recruiting from the STEM pipeline due to the shortage of a qualified STEM workforce and access to talented youth in STEM fields (Borgerding, 2015; Christensen, Knezek & Tyler-Wood, 2015; Logue, Watanabe-Rose & Douglas, 2016; Noonan, 2017; National Research Council, 2012; Wei, 2014). The shortage of a qualified STEM workforce is repeatedly connected to poor academic preparation in secondary school and lack of a diverse talent pool to pursue degrees in STEM fields (Enberg & Wolniak, 2013). A study conducted by Enberg and Wolniak (2013) found that more research is needed to better understand the role of different high school programs to address the postsecondary preparation and STEM degree pursue systemic issues in the U.S. Moreover, participation in advanced curriculum and postsecondary outreach programs was found to improve sustained interest for all students, including URMs and low-SES, into the STEM pipeline (Andersen & Ward, 2014;

Andrews & Stange, 2016; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Carnevale, Cheah & Hanson, 2015; Enberg & Wolniak, 2013; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Stephens, Hamedani, & Destin, 2014; Suziedelyte & Zhu, 2015). The preparation and skills acquired from high school programs that linked advanced placement and college preparations may also provide the means for persistence and self-efficacy in the post-secondary STEM pipeline (Enberg & Wolniak, 2013). The national workforce gap in STEM begins with closing the gap in STEM education and understanding the factors that impact successful education and career trajectories throughout a student's future STEM pipeline and is critical for promoting a growing and sustainable national security STEM workforce across the federal government, industry and academia.

Attainable postsecondary pathways. Understanding what is attainable in the future while in the adolescent stage can be difficult for one to envision, therefore it is important for one to clearly see the pathway ahead as a reachable next step (Cover, Jones, & Watson, 2011; Luo & Holden, 2014). Numerous research studies show evidence that AAP curriculum and outreach programs provide students with the foundation for college success and contribute to increased postsecondary access (Chajewski, Mattern, & Shaw, 2011; Pell Institute, 2009; Walsh, 2011). Within AAP courses, the peer-climate cultivates a college attending goal oriented culture with a faster and deeper dive into the curriculum content than the general education classes. Additionally, the classroom sizes are typically smaller allowing for more one-on-one discussion and project-based learning to engage student in areas linked to real-world careers or challenges providing practical application for college preparedness. Moreover, researchers have found that taking AAP mathematics and science curriculum in high school has been attributed to a factor of success through the STEM workforce pipeline (Chen & Weko, 2009; LeBeau et al., 2012). Researchers have found that increased access to AAP curriculum that includes college planning, mentoring, and exposure to STEM-related occupations while in elementary, middle school and high school has the strength to impact persistency of diversity in STEM occupation pathways to include self-efficacy development as an influencer (Joy, 2006; Museus, Palmer, Davis, & Maramba, 2011).

Therefore, if educators within both secondary and postsecondary STEM programs recognize the factors to expand entry into the STEM pipeline for URM and low-SES students, further steps can be taken to reach student who might not otherwise be reached through advanced education programs, afterschool enrichment offerings, and inspire the next generation of STEM workers in the labor workforce to serve in government as a Federal employee, work in industry, or contribute to the body of knowledge in academia. Promoting the importance of STEM fields in all labor markets to URMs in secondary education before the critical juncture of transition to college occurs is important to ensure that the students are motivated and secure a strong self-efficacy to pursue the STEM pipeline journey in postsecondary education (Hwang, Choi, Lee, Culver & Hutchison, 2016; Konstantopoulos, 2006; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Rubenstein, Siegle, Reis, Mccoach & Burton, 2012; Sen, 2016; Wang, Chu-Chun, & Rice, 2012). Students need to recognize that the pathway in STEM is a goal that can be reached and any stereotypes about the career need to be shut-down and clarified. The truth about the employer, the occupation, and the opportunity need to be presented to the student instead of barriers of the past or challenges to overcome; instead present benefits awarded to the student, and share stories of other URMs students who have succeeded in STEM achievement, to increase interest and perseverance through the STEM pipeline among the URM and low-SES groups (Blustein et al., 2013; Bohrnstedt, Kitmitto, Ogut, Sherman & Chan, 2015; Bottia, Stearns, Mickelson, Moller & Parker, 2015; Kastberg et al., 2016; Kettler & Hurst, 2017; Noonan, 2017; Stocklmayer, Rennie, & Gilbert, 2010). Researchers have found that certain factors influence a student's decision to attend college including SES status, academic preparation influence, and the field of study and occupation that the student has decided to pursue (Alvarado & An, 2015; Azevedo, diSessa, & Sherin, 2012; Martinez & Guzman, 2013; Cover, Jones, & Watson, 2011; Negru-Subtirica & Pop, 2016; Sadler, Sonnert, Hazari & Tai, 2014). Additionally, the majority of STEM-related occupations require a bachelor's degree or higher.

According to the U.S Bureau of Labor Statistics (2017), on average Latino/Hispanic and African American/Black households spent significantly less on postsecondary education than Caucasian/White Americans by 57 percent and 69 percent, respectively. On the other hand, between the years 2008 and 2010, Asian Americans spent approximately 57 percent more on tuition than Caucasian/White Americans (Luo & Holden, 2014). Researchers have studied cultural differences among the demographic groups, parent choices as student influencers, resource and scarcity in low-SES of which all could be attributed, in part, for the postsecondary education of the youth (Andersen & Ward, 2014; Andrews & Stange, 2016; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Carnevale, Cheah & Hanson, 2015; Gonzalez, 2012; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Stephens, Hamedani, & Destin, 2014; Suziedelyte & Zhu, 2015). Additionally, the financial impact may be a liming factor for some low-SES URMs, for example, Gonzalez (2012) conducted a study and found that Latino/Hispanic students generally have higher initial enrollment rates at community colleges that are 2-year institutions of which the tuition rates are significantly lower than 4-year universities. Furthermore, the U.S. Bureau of Labor Statistics (2014) reported that 40 percent of the U.S. high school graduates enrolled in 2-year institutions, while 60 percent enrolled in 4-year intuitions. It is important to understand the critical juncture from high school graduation transition to college and if a student chooses a 2-year institution, the pipeline into a 4-year STEM degree from a community college should be clear to them as they map out their STEM education to workforce pathway.

Postsecondary pathways may have numerous motivations, including economic factors considers and parents influencers who may not have attended college and find the immediate income of a paid job after high school as a near-term solution to low-SES real family challenges (Blustein et al., 2013; Bohrnstedt, Kitmitto, Ogut, Sherman & Chan, 2015; Bottia, Stearns, Mickelson, Moller & Parker, 2015; Kastberg et al., 2016; Kettler & Hurst, 2017; Noonan, 2017; Stocklmayer, Rennie, & Gilbert, 2010). The model that Chapman (1981) proposed that embodied student characteristics and external influencing factors such as college attributes and influential relationships for a college-pursuing model and comprised of academic achievement, aptitude, SES, and educational aspirations. The college attributes included cost and location. The findings of Chapman's research and model suggest that information collected by students during high school and the parent influencers, were prominent factors of a student's decision to attend college. Characteristics that were connected to SES impeded students' decisions to attend college included cost, location, and college type (Chapman, 1981). Additionally, it is important to note that the study found a correlation between SES status and attitudes, aspirations, and behaviors related to college attendance. Students with higher aspirations generally experienced higher levels of academic success and optimism about future education while information during high school strengthened student aspirations as an aid to balance any negative SES effects.

Critical Juncture of High School. Some researchers have examined the connection between high school activities, to STEM field discipline-specific postsecondary education outcomes (Engberg & Wolniak, 2013; Moller et al., 2015). In a research study conducted by Engberg and Wolniak (2013) using a nationally-representative sample of college students who recently experienced the critical juncture from high school and analyzed the effect of high school education factors on a college-level STEM education outcome. The researchers measured numerous factors, including student self-efficacy, academic preparation, high school emphasis on STEM career pathways, attitudes and dispositions, college choice considerations, and recent postsecondary experiences. The individual students' academic preparation, attitudes, self-efficacy, and science dispositions during high school were accurate predictors of the STEM major declaration (Engberg & Wolniak, 2013). However, the study found that the high school activities, such as academic press, school morale, and school safety, did not have a significant impact on students' college education outcomes on STEM major declaration (Engberg & Wolniak, 2013).

Moller (2015) conducted a study to examine students' published papers who were attending public colleges and universities in North Carolina to describe the effect of one particular high school's practice on STEM major declaration. The study examined enrollment from 12,132 students and survey data from 6,527 secondary school teachers in 327 schools (Moller et al., 2015). Moller (2015) observed the relationship between the teaching environment in high schools and the enrollment in a STEM major in college. The researchers created the latent independent variable derived using factor analysis while controlling for teacher quality, teacher turnover, and other school inputs such as low-SES. Six subject areas were used when questioning teachers in (a) the teaching environment, (b) the administrative relationship, and (c) professional satisfaction. The study found that the teaching climate was a significant predictor of a student's decision to major in a STEM field for Hispanic/Latino students, but not for students of other racial/ethnic backgrounds. The school teaching climate is important for all students, but Moller (2015) found that the teaching environment impacts Hispanic/Latino students to a greater degree because Hispanic/Latino students have limited exposure to STEM outside of school. Moreover, Moller (2015) found that Hispanic/Latino students are more likely to progress successfully through the STEM pipeline with teachers that encompass characteristics that include compassion, support, engagement, and care of which are found in schools with positive teaching climates working in collaborative professional teaching communities.

Factors affecting postsecondary education persistence and success. Researchers have conducted numerous correlational studies to determine postsecondary readiness outcomes as related to the intensity of the curriculum which have found a strong association between curricular intensity and general postsecondary outcomes such as enrollment, selectivity, readiness, persistence, and graduation (Aughinbaugh, 2012; Bottia, Giersch, Mickelson, Stearns, & Moller, 2015; Rohr, 2012; Zelkowski, 2011). The low-SES composite school affects that impact a student's postsecondary academic achievement outcomes were investigated by multiple research studies and found that URM students and students from low-SES schools were less likely to have access to the advanced mathematics and science curriculum that provides intense coursework (Kelly & Sheppard, 2009; Museus, Palmer, Davis, & Maramba, 2011). Furthermore, numerous researchers found the effects in high school advanced science curriculum to have a significant positive impact on postsecondary success and outcomes (Aughinbaugh, 2012; Bottia, Stearns, Mickelson, Moller, & Parker, 2015; Gottfried & Bozick, 2016; LeBeau et al., 2012; Legewie & DiPrete, 2014).

A research study was conducted by Palardy (2013) that examined a nationally-representative sample of high school students who were academically eligible for postsecondary education in 2004 to determine the effect of the high school SES composite on college enrollment. The study did not find any student-level differential effects across 2-year and 4-year institutions and did not find any varying factors across high school students that indicated a school had a greater impact on postsecondary education. Overall, the high school SES status effect was consistent for students regardless of SES, ethnic background or school practice differences. Students who attend high-SES schools were 68 percent more likely to attend postsecondary school (Palardy, 2013). A mediating factor that was analyzed in the study included the effect of peer influences and school practices, concluding that peer influences had more of an effect than school practice effects.

Achievement Gap in STEM. The achievement gap in STEM education was found among URMs, primarily students from Black/African American and Hispanic/Latino populations, and the non-URMs identified as the students who achieve higher scores across the U.S. which are generally from Asian and Caucasian/White populations. Over the past few decades, the STEM education achievement gap has continued to widen among the URM and non-URM population groups with a majority of the URMs residing in a low-SES location and attending schools with low-SES composite. Many factors impact the achievement gap in STEM education and must be considered when investing in STEM to address the diversity workforce issue. The majority of research studies in STEM on education, specifically in mathematics, have been done at the higher elementary, middle school, high school, or postsecondary levels (Crosnoe, 2010; Hekimoglu, 2010; Inglis & Miller, 2011; McAdams, 2012).

Although the achievement gap in STEM education is focused on in-school education, the majority of school age youth spend only 20-percent time in schools while 80 percent is spent outside of school, including in out-of-school STEM programs (Stevens, Bransford & Stevens, 2005). Bridging the achievement gap involved dynamic strategies to support STEM learning that involve inquiry-based pedagogy, hands-on learning, and connect with real-world STEM experiences that can be widely applied while connected to in-school curriculum and out-of-school programs. Research has found that out-of-school STEM programs can be an important turning point for implementing comprehensive and lasting improvements in STEM education through hands-on activities, low-pressure/ungraded activities, multi-age groupings, flexible uses of time to inspire, sustain, and deepen the youth's interest in STEM fields and develop an understanding and commitment to scientific, technology, engineering, and mathematical communities (Falk & Dierking, 2010; Overton, 2015; Shankar & Kalil, 2013; Traphagen & Traill, 2014).

Education disparities in high school mathematics and science among African Americans/Blacks. African Americans/Blacks are the third largest (14.4 percent) racial ethnic group in the U.S. (Atwater, Johnson, Lance & Woodard, 2013). Education disparities among African American/Black adolescents in high school were examined by Newton & Sandoval (2015) to assess the educational expectations and the value of education among suburban St. Louis, Missouri and low- to moderate-level income. The quantitative study examined the following factors: teachers' expectations, perceptions of parents' expectations, and neighborhood quality. The results of the study found that the perceptions of the expectations of parents and teachers were associated with student educational expectations and value of education and some demographic variables were also associated. African American/Black students' ambitions may represent educational hopes and desires; however, one's ultimate educational attainment was found to be motivated by tangible self-efficacy toward educational opportunities (Newton & Sandoval, 2015; Riccitui 2010; Roderick, 2003; Rollins & Valdez, 2006). For many African Americans/Blacks, educational opportunities are often shaped by stereotypes, lack of resources, low teacher expectations, and social barriers (Newton & Sandoval, 2015; Wood, Kurtz-Costes, Okeke-Adeyanju & Rowley, 2010). Studies show that African American/Black boys hold higher educational expectations for their female counterparts (Newton & Sandoval, 2015).

Challenges that hinder African American/Black students include (a) environmental factors, (b) parental limited aspirations, (c) income level, (d) education perceptions, (e) discrimination and prejudice, (f) disabilities, and (g) expectations (Atwater, Johnson, Lance & Woodard, 2013; Balfanz, 2009; Burt, Ortlieb & Cheel, 2013; Garrett, Barr & Rothman, 2009; Hester & Pellowski, 2014; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015; West-Olatunji, Saunders, Mehta & Behar-Harenstein, 2010). The environment challenges include invalidated and hostile atmospheres along with cultures that foster alienation from each other. Research shows that there is a lack of aspiration for the African American/Black child with regard to parental aspirations. African American/Black students face income level challenges that place students in poverty, low-SES class, low-income schools, and on free or reduced lunch plans. The disabilities that students face include reading, learning-language, and comprehension. Discrimination and prejudice is a challenge that African American/Black students face that includes bullying, name calling, unequal opportunities, treated unfairly, and degraded. All of the discrimination and prejudices challenges can have long-term and significant impacts on a student's self-efficacy development.

Research shows that 75 percent of African American's were concerned for their future (Atwater, Johnson, Lance & Woodard, 2013; Balfanz, 2009; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015). Parent aspirations are generally low for their African American/Black children (Burt, Ortlieb & Cheel, 2013; Garrett, Barr & Rothman, 2009; Hester & Pellowski, 2014; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015). Likewise, teachers also hold lower expectations for African American/Black students than Caucasian/White students (Burt, Ortlieb & Cheel, 2013; Garrett, Barr & Rothman, 2009; Hester & Pellowski, 2014; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015). Moreover, the expectations are lower for African American/Black males than they are for African American/Black females (Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015).

The education disparities among African American/Black education compared to Latino/Hispanic education are found in high school completion types, college attendance rates, and characteristics as shown in Table 1. In 2011, there were 3.9 million African American/Black students attending U.S. colleges compared to 2 million Latino/Hispanic students (Burt, Ortlieb & Cheel, 2013; Garrett, Barr & Rothman, 2009; Hester & Pellowski, 2014; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015). Research shows that 18.7 percent of African American/Black students over the age of 25 attained a 4-year bachelor's degree, where 15.5 percent of Latino/Hispanics earned a 4-year bachelor's degree (Atwater, Johnson, Lance & Woodard, 2013). Additionally, 85 percent of African American/Black students over the age 25 of received their high school diplomas where 66.7 percent of

Latino/Hispanic students earned their high school diploma (Atwater, Johnson, Lance & Woodard, 2013; Balfanz, 2009).

Table 1

Student High School Completion and Enrollment Data by Demographic Subgroup

Student Subgroup	Received High School Diploma	Received GED or Other Equivalency	Enrolled in High School	Dropped Out of High School
African American/Black	83.2%	4.5%	5.4%	6.9%
Latino/Hispanic	95.9%	1.3%	0.6%	2.2%
Asian	86.0%	2.4%	5.6%	6.0%
Caucasian/White	91.6%	2.5%	3.3%	2.7%
All Students	88.8%	2.8%	4.2%	4.2%

Characteristics of an African American/Black student included (a) behaviors, (b) social and economic statuses, (c) percentage of student populations, (d) test and assessment scores and rankings, and (e) parental involvement (Atwater, Johnson, Lance & Woodard, 2013; Balfanz, 2009; Burt, Ortlieb & Cheel, 2013; Garrett, Barr & Rothman, 2009; Hester & Pellowski, 2014; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015; West-Olatunji, Saunders, Mehta & Behar-Harenstein, 2010). Behavior characteristics of African American/Black students included high attendance rates, open and accepting to the gifted label, disassociate from the label of disability, and majority (75 percent) voice a concern for their future (Balfanz, 2009). Social and economic status characteristics of African American/Black students included that a majority (90 percent) of the students attending predominately African American/Black elementary school tend to receive free of reduced lunch, and are within higher poverty levels (Atwater, Johnson, Lance & Woodard, 2013). Percentage of student population characteristics included that nearly one third of Latino/Hispanic and African American/Black students attend majority minority high schools (90 percent URMs) while their Caucasian/White counterparts attend schools that are majority Caucasian/White (90 percent or greater non-URM)

(Newton & Sandoval, 2015). Test, assessment scores, and ranking characteristics included speech disruptions in the narratives of African Americans/Blacks with reading disabilities (Hester & Pellowski, 2014; Mayes & Moore, 2016). Furthermore, studies showed less than ideal parent involvement occurs in young African American/Black student learning at home and challenges that African American/Black students face stem from the home environment (Burt, Ortlieb & Cheel, 2013; Garrett, Barr & Rothman, 2009; Matto, Spera & Wentzel, 2008; West-Olatunji, Saunders, Mehta & Behar-Harenstein, 2010).

Education disparities in high school mathematics and science among Hispanics/Latinos. As the Latino/Hispanic population continues to grow, its education development in STEM fields, U.S. political integration, and civic and military education and outreach will be important to the nation's future (Bedolla, 2012; Flanagan & Levine, 2010; U.S. Bureau of Labor Statistics, 2017; Walker & Pearsall, 2012). Many students who are Latino/Hispanic often have difficulty understanding the content area vocabulary for mathematics and science which can hinder learning and directly affect education achievement outcomes (Landivar, 2013; McAdams, 2012; Proctor, 2011; Walker & Pearsall, 2012). Limited funds are available in education which provide a small number of select programs in high schools to provide the STEM education and civics courses needed which may not be meeting the demographic population's needs with regard to advanced STEM curriculum with English vocabulary content assistance and civics integration to achieve academic outcomes for the Latino/Hispanic population for college preparedness (Jamieson, 2013; Kanter & Schneider, 2013; McAdams, 2012; Walker & Pearsall, 2012).

Researchers have found that challenges within the Latino/Hispanic student populations in STEM education may be due, in part, to the language barriers of being bilingual or English Language Learners (Proctor, 2011). Additionally, research shows that Latino/Hispanic students from low socio-economic households are less likely to have mastered prerequisite vocabulary than their more economically advantaged and English speaking peers (McAdams, 2012; Proctor, 2011). Learning mathematics and science concepts was found to be challenging for a student who has already mastered the English language. Programs with non-traditional models to help reinforce the English language and teach STEM to students is needed in schools. According to researchers, the traditional model of pre-teaching English vocabulary for a particular unit of instruction is not as effective as teaching vocabulary as a pre- and post- unit course and reviewing it frequently (McAdams, 2012). Moreover, online English and STEM vocabulary intervention and the use of Vocabulary Builder graphic organizers are two methods of increasing students' mathematics vocabulary and achievement of which should be integrated in the course curriculum for Latino/Hispanic students in STEM courses (McAdams, 2012; Proctor, 2011). Furthermore, problem-solving, using science and mathematics in realistic applications, and incorporating a terminology list for each STEM unit of instruction can also improve science and mathematics vocabulary acquisition for Latino/Hispanic students (Bohrnstedt, Kitmitto, Ogut, Sherman & Chan, 2015; Bottia, Stearns, Mickelson, Moller & Parker, 2015; Inglis, 2011; Gonzalez, 2012).

Education performance in mathematics and science among non-URMs. The academic performance in mathematics and science among non-URMs, which include student from Asian and Caucasian/White populations have remained historically higher than the URMs in the U.S. (Le Hebel, Montpied, Tiberghien & Fontanieu, 2017). However, researchers have found that globally the U.S. was not among the top high school performer according to the Programme for International Students Assessment (PISA) data (Le Hebel, Montpied, Tiberghien & Fontanieu, 2017; Lewis, 2017; Prenzel, Kobarg, Schöps & Rönnebeck, 2013). Le Hebel, Montpied, Tiberghien and Fontanieu (2017) studied the difficulty of the test questions within the PISA exam that provides a global assessment of 15-year-old students on essential knowledge and skills acquired for full participation in society; however, there were recommendations for further improvements in the questions to assess mid- and low-proficiency level accuracy. Some educators and decisions makers have thoughts around teaching children in heterogeneous groups to benefit all students while providing resource access to low-SES students, while others disagree and state that whole group instruction slows the progress of learning for advanced students (Borman & Dowling, 2010; Fielder, 2002; Perry, 2012).

Researchers have investigated the differences in STEM attitudes due to the disparity of underrepresentation of women and minorities in the STEM workforce although there are similarities among women and men in mathematics and science achievement, women continue to be underrepresented in STEM education and in the workforce across all demographic groups (Bell, Tzou, Bricker & Baines, 2012; Else-Quest, Mineo & Higgins, 2013). The cognitive ability of mathematics is natural whereas dependency variables linked with nurturing can be related to creativity which creates an interesting intersection of fluency and flexibility with regard to mathematical approaches (Pitta-Pantazi, 2011). Each student develops creative thought processes differently; therefore, allowing gifted students to explore creative freedom in mathematics provides education growth opportunities unique to one's unique needs while overcoming the potential for group-think in the classroom (Kamalnath, 2017; Pitta-Pantazi, 2011). There was a linkage between mathematical giftedness and mathematical creativity

(Leikin, 2011). Likewise, science talent requires creativity and, according to research studies, in many cases integrated mathematics and science instruction enable a high-level learning environment (Donavan, 2017; Kim, Roh & Cho, 2016). Additionally, natural mathematical abilities can predict future achievement, but must be nurtured to maintain the level of attainment and growth (Davidson, 2009; Leikin, 2011; Pitta-Pantazi, 2011).

STEM education and competencies needed for college readiness. Preparing high school students for postsecondary success is important to ensure that the education foundation is properly in place for students to build upon more complex learning in college and build the quality youth whole of civil society (Baum et al., 2013). The benefits of college have been quantified through salary comparisons to average annually salaries that one can attain with a college degree resulting in greater access to jobs and higher salaries (Autor, 2014; Carnevale, Rose, & Cheah, 2014). While preparing students to embark on the college journey, high schools have a large amount of curriculum to cover from the standard level required for graduation to the advanced level to project students into STEM advancement at colleges and universities through AAP coursework. Brint & Clotfelter (2016) investigated the college enrollment rates of adolescents and found that college enrollment rates have been increasing over the past few decades and according to the National Center for Education Statistics nearly two-thirds of high school graduates in 2013 applied to colleges (NCES, 2016a). However, the college graduation rates do not reflect the high application rates and college degree attainment disparities are found across SES, ethnicity, and diversity differences among students (Brint & Clotfelter, 2016; Cahalan & Perna, 2015; Duncan & Murnane, 2011; Tierney & Duncheon, 2015).

A strong foundation in science and mathematics is needed as a baseline for entry into college to fulfill the STEM competencies required for remedial courses (Education Research of America, 2016). Graduation diplomas range in quality and some do not have the rigorous core STEM courses required in high school for college entry success. Advanced academic curriculum in STEM ensures the students received the right foundation for college entry. As with the high school diploma, high school graduation rates vary considerably across race/ethnicity groups in the U.S. showing 70 percent for Asian, 63 percent for Caucasian/White, 53 percent for Hispanic/Latino, 41 percent for African American/Black, and 41 percent for Native American (NCES, 2016a). College completion rates vary according to graduating class and by the time young adults turn 24 years old, 77% of those in the top income quartile have graduated while only 9% of the students in the bottom income quartile have earned bachelor's degrees (Cahalan & Perna, 2015).

Advanced academic curriculum programs. Since 2004, student enrollment in AAP courses has doubled in size with minority students showing significant increases in participation (College Board, 2014a). Studies have shown that students who participate in AAP programs are linked to higher rates of college enrollment and retention, including higher levels of social and academic capital (Mattern, Marini, & Shaw, 2014; Shaw, Marini, & Mattern, 2012). Researchers found that students who participated in academically advanced placement programs show higher levels of interest in fields that require an investigative skill, such as science and technology, which led to STEM education fields and occupations of interest (Siobhan, Mckillip & Smith, 2013; Sparfeldt, 2007). Academic Advanced Placement (AAP) allows students to take rigorous college-level coursework in specific subject areas while attending high school and earn college credits (College Board, 2014a). According to the College Board (2014b), more than 90% of universities and colleges in the U.S. offer higher education credit for qualifying scores on AAP exams. Advanced academic curriculum programs in high school promote the enrollment of students in postsecondary institutions (Ackerman, Kanfer & Calderwood, 2013; College Board, 2014a). In 2011, over 940,000 high school students' submitted AAP scores to 3,300 universities, and colleges for enrollment consideration and credit acceptance (College Board, 2014a).

Participation in advanced academic curriculum in-school and out-of-school could be a component advantageous for postsecondary participation and the decision-making process for STEM field choices. The STEM AAP curriculum courses and examinations have been proven to be more rigorous than traditional curriculum and tests. The curriculum instills a higher level of proficiency and academic achievement in mathematics and science in students. Additionally, students can obtain STEM knowledge of college-preparation activities through out-of-school programs also through outreach programs or tutors. Researchers have examined the college-attendance behavior of students as it relates to the AAP exams taken during high school and found that there are significant correlations between AAP participation in high school and college attendance (Chajewski, Mattern and Shaw, 2011; Klugman, 2012). Chajewski, Mattern and Shaw (2011) conducted a study using a national data consisting of 2007 high school seniors and the researchers found that the number of AAP exams taken were associated with an increased likelihood of enrollment in postsecondary institutions, in fact, students who took an AAP exam were twice as likely to attend college than who did not take an AAP exam. Moreover, high school students who took a minimum of two AAP exams had an even greater chance of attending college. Students who participated in AAP exams and coursework earned higher Preliminary Scholastic Aptitude Test (PSAT) scores than students who did not participate in AAP courses, which suggests that higher levels of overall academic performance exist in the student participating in AAP courses and exams (Chajewski, Mattern and Shaw, 2011; Klugman, 2012). Notably, the findings suggested that gender and ethnicity did not have a significant role in the likelihood of the student enrolling in postsecondary institutions although participation in the AAP curriculum may be limited by school resources and SES composition of the school (Chajewski, Mattern and Shaw, 2011; Klugman, 2012). The study examined 710 high schools in the U.S. on the basis of programmatic resources (advanced academic courses), social resources (social relations), and pedagogical resources (teacher training) while evaluating the relationship between course offerings and SES, and the relationship surrounding school resourcing which found that the higher-SES status and the more diverse program offerings available, the more probable students are to enroll in postsecondary education (Klugman, 2012).

Advanced academic curriculum and equity concerns. Researchers have investigated the connection between AAP participation and education outcomes and equal opportunity concerns among diverse populations (Howard-Brown and Martinez; 2012; Klugman, 2012; MacPhee, Farro & Canetto, 2013). Howard-Brown and Martinez (2012) conducted research focusing on diverse learners and providing STEM education learning opportunities. Some research suggests that the financial obligations of an advanced curriculum and financial obligations of postsecondary education may inhibit participation in such programs for underrepresented students (Walker & Pearsall, 2012; Castleman, Long & Mabel, 2018; Baum, Ma & Payea, 2013; Black, Lincove, Cullinane & Veron, 2015). There is a cost for schools to participate in an advanced curriculum and the students see the increased costs on the materials list for the academic school year or fees for the AAP course exams in some cases (College Board, 2014b). According to the College Board (2014b), AAP courses may have a start-up cost for the school up to $11,000 to integrate the advanced classes into the current course offerings and is not a one-time expense. Establishing advanced curriculum in a school encompasses long-term preservation costs that include materials, equipment, and teacher professional development. The increased cost of school supplies can seem overwhelming when families are struggling to meet physiological needs.

Researchers found that when URMs participate in the AAP curriculum, the college enrollment and completion rates for URM students is higher for students with AAP course experience in post-secondary education which was evidence of AAP curriculum success for minority students and that the academic rigor in the AAP curriculum provides college readiness (Martinez, & Guzman, 2013; Martinez & Klopott, 2005; McCauley, 2009). Walker and Pearsall (2012) conducted a qualitative study on high school students in the U.S. to understand Hispanic/Latino students' access and participation in AAP courses. The study found that all students met the requirements to participate in the AAP courses, however, the cost was a significant limiting factor for participation. Additionally, students lacked understanding of the connection between AAP courses and influence on a decrease cost of college tuition. For example, participation in AAP courses should be associated with earning a qualifying score on the AAP exams and saved time required for college graduation and receiving reduced college tuition, however the future benefits were not clearly communicated and associated as a value to Hispanic/Latino students and their parents.

Participation in advanced academic curriculum in-school and out-of-school could be a component advantageous for postsecondary participation and in the decision-making process for STEM field choices. The STEM AAP curriculum courses and examinations have been proven to be more rigorous than the regular curriculum and tests. The curriculum teaches students a higher level of proficiency and academic achievement in mathematics and science. Additionally, students can obtain STEM knowledge of college-preparation activities through out-of-school programs also through outreach programs or tutors. Researchers have examined the college-attendance behavior of students as it relates to the AAP exams taken during high school and found that there are significant correlations between AAP participation in high school and college attendance (Chajewski, Mattern and Shaw, 2011; Klugman, 2012). Chajewski, Mattern and Shaw (2011) conducted a study using a national data consisting of 2007 high school seniors and the researchers found that the number of AAP exams taken were associated with an increased likelihood of enrollment in postsecondary institutions, in fact, students who took an AAP exam were twice as likely to attend college than who did not take an AAP exam. Moreover, high school students who took a minimum of two AAP exams had an even greater chance of attending college. Students who participated in AAP exams and coursework earned higher Preliminary Scholastic Aptitude Test (PSAT) scores than students who did not participate in AAP courses, which suggests that higher levels of overall academic performance exist in the student participating in AAP courses and exams (Chajewski, Mattern and Shaw, 2011; Klugman, 2012). Notably, the findings suggested that gender and ethnicity did not have a significant role in the likelihood of the student enrolling in postsecondary institutions although participation in the AAP curriculum may be limited by school resources and SES composition of the school (Chajewski, Mattern and Shaw, 2011; Klugman, 2012). Across the U.S., 710 high schools were examined on the on the basis of programmatic resources (advanced academic courses), social resources (social relations), and pedagogical resources (teacher training) while evaluating the relationship between course offerings and SES, and the relationship surrounding school resourcing which found that the higher-SES status and the more diverse program offerings available, the more probable students are to enroll in postsecondary education (Klugman, 2012).

Student challenges in advanced academic placement. Most of the studies that investigated the challenges that students face in AAP courses were in the interest of improving education outcomes across all education curriculum in STEM and non-STEM, and diversity in the student population as well as the non-URMs. The focus of research on student challenges in AAP was directed toward studies that presented findings on educations outcomes, and URMs in STEM. There is a concern among society and educators that U.S. students are falling behind the rest of the world in mathematics achievement proven by global performance high school metrics, which is why differentiation was used in mathematics (Crosnoe, 2010; Kastberg, Ying Chan & Murray, 2016; Principles and Standards of School Mathematics, 2011).

Researchers have different thoughts around how to solve the issue of academic placement and student challenges. According to research conducted by Crosnoe (2010) some mathematic educators contend that a common mathematical curriculum grounded on an abstract understanding to teach to students across all levels together is the best way for disadvantaged children to learn at the same rate as advanced students while other educators feel that one curriculum is too challenging for disadvantaged students because of their lack of readiness and it will slow the progress of the other students learning at a higher level (Crosnoe, 2010; Fielder, 2002; Vygotsky, 2011). Crosnoe (2010) found that including disadvantaged students in the core curriculum while providing additional educational support allowed the disadvantaged students to close the achievement gap considerably, as long as the students had a decent relationship with the teachers through cultural-responsive teaching techniques (Aceves & Orosco, 2014; Basile & Lopez, 2015).

Models of Self-Efficacy. Five models of self-efficacy include self-believe, self-regulation, self-evaluation, self-stimulation, and self-monitoring (Sen, 2016). Self-believe includes judgement of confidence, while self-regulation entails learning skills with baselining such as goal setting, staying organized encompassing the environment and time, seeking help and self-evaluation (MacPhee, Farro & Canetto, 2013; Sen, 2016). Self-stimulation involves planning, goal-setting, strategizing, and setting expectations in reference to a goal. Self-monitoring is essentially progress management. Each self-efficacy model can be measured on a scale based on a students' mathematics or science self-efficacy level for compliance with STEM competencies.

Embedded within each self-efficacy model was the effectiveness of mentoring an individual to achieve the true potential that he or she truly can become. Sahin (2014) conducted a study to assess the effectiveness of mentoring strategies for gifted and non-gifted students (2014). Gifted students tend to challenge each other to higher attain a greater achievement through both cooperative and competitive classroom practices, while average and low performing students improve their self-efficacy working in aptitude groups because it provides one the opportunity to be successful instead of being dominated by gifted students who comprehend new concepts without difficulty and fast (Pitta-Pantazi, 2011). Research has shown that many students improve their self-efficacy when they see students of the same ability succeeding, of which that success then transfers to a level of confidence of one's own chances for success (Bandura, 2001; Holsen, Larsen, Aardal, & Geldhof, 2016).

Failure must be looked upon as a lesson to learn from, instead of deflating one's motivation and the level of self-efficacy; students must learn to accept failure and feedback in a healthy manner to press forward (Moser, 2012). There is a cycle of school failure that has an impact on disadvantaged students of which impacts the assertion that treatment among the academic tracks is unequal and that students in the low track receive substandard instruction, while smart students benefit at the expense of less capable students (Ankrum, 2008; Ansalone, 2004; Bottge, 2007; Crosnoe, 2010).

Online problem-solving competitions provide a way for students to persist through unusual paths; therefore, programs such as Math Olympiads can provide opportunities for students to identify as mathematically gifted students through the observance of extraordinary mathematics achievement in the regular classroom increasing self-efficacy (Karp, 2011; Psycharis & Kallia, 2017). Computer programming in high school can provide a gateway to building positive self-efficacy in science and mathematics (Psycharis & Kallia, 2017). A quasi-experimental study was conducted by Psycharis and Kallia (2017) to determine the impact on high school student's reasoning skills, problem solving and self-efficacy specifically in mathematics which found that there is a significant difference in the reasoning skills of students that participated in the computer programming courses as compared to students that did not. Self-efficacy was found to be an indicator of students who participated in the experimental group of which showed a significant difference from students in the control group in achievement of problem solving in mathematics in the computer programming course (Psycharis & Kallia, 2017). Problem solving is a process that encourages one to make connections, draw upon critical thinking, and apply one's knowledge, particularly in the fields of mathematics and science, to real-world challenges. Problem solving is a higher order of thinking that requires a cognitive skillset for students to synthesize knowledge that they have gained and strategize how to solve future problems through mathematical and scientific thinking, writing, and verbal communication. Students understanding of the importance of collaboration among peers through the use of work samples to guide students, assess students, aide students in self-reflection, and encourage students to uncover novel ideas in mathematics and science through problem-based instruction can be fostered within the classroom (Inglis, 2011). Problem-solving and self-efficacy is correlated with a higher conceptual understanding of mathematics, improved reasoning across mathematics and science, and higher achievement in mathematics and science (Cave, 2010; Kandlhofer & Steinbauer, 2016; Welch, 2010; Spinner & Fraser, 2002). Researchers have found that competitions are a successful avenue for fostering positive self-efficacy in youth in STEM through increased students' attitudes, allowing deep-content knowledge gain in an informal environment out-of-school, development of team spirit mentality, and awareness of pathway to future careers in STEM (Kandlhofer & Steinbauer, 2016; Welch, 2010). Welch (2010) conducted a study to examine high school students' attitudes toward science after participating in the national *For Inspiration and Recognition of Science and Technology (FIRST)* robotics competition measuring seven categories of social implications using the Test of Science Related Attitudes (TOSRA) (Fraser, 1982) The TORSA is used to assess and measure students' related attitudes toward science along seven categories to include (a) social implications of science, (b) normality of scientists, (b) attitude toward scientific inquiry, (c) adoption of scientific attitudes, enjoyment of science lessons, (d) leisure interest in science, and (e) career interest in science (Fraser, 1982; Kandlhofer & Steinbauer, 2016). The results of the study indicated that students who participated in the *FIRST* robotics competition had a more positive attitude toward science and science, specifically social implications of science, normality of scientists, attitude toward scientific inquiry, and adoption of scientific attitudes (Welch, 2010).

In Mathematics, the Test of Mathematics Related Attitudes (TOMRA) is a Likert scale assessment that can be used to assess and measure students' attitudes in four criteria which include (a) normality of mathematics, (b) attitudes towards mathematic inquiry, (c) adoption of mathematics attitude, and (d) enjoyment of mathematics lessons (Awang, Ilias, Che Hussain & Mokhtar, 2013; Fraser, 1982; Spinner & Fraser, 2002). Researchers have conducted studies in mathematics classrooms using the TORMA assessment and have found constructivist and individualized classroom learning environments promote both conceptual development and positive attitudes leading to stronger student self-efficacy in mathematics (Spinner & Fraser, 2002). Mathematic equations are used to solve problems in real-world practical applications and science theory is seen in action every day; therefore, mathematics and science instruction should focus on the linkage of applied mathematics and science (Inglis, 2011). It is important for students to have basic mathematics facts memorized to build confidence and attitude toward ability in attainment while developing the computational fluency to pursue critical thinking skills and more complicated tasks that included problem solving (Smith, 2011). Teachers can be key stakeholders for student engagement and provide authentic transition from the standard in-person classroom learning to e-learning (Kisanga & Ireson, 2016). Researchers have investigated the scale of teachers' self-efficacy using 36 items on the Test of e-Learning Related Attitudes (TeLRA) to determine the impact in student learning which validated the TeLRA scale and found a teacher's self-efficacy has a significant link to classroom integration to eLearning success (Kisanga & Ireson, 2016).

Research has shown that in some cases teachers have shown to show frustration with low achieving students which can increase the students' lack of confidence and dislike for learning and school activities leading to low self-efficacy and academic achievement and a decline in cognitive growth (Crosnoe, 2010). Furthermore, researchers have found a strong positive correlation found between students' attitudes and self-efficacy perceptions towards mathematics (Yavuz Mumcu & Cansiz Aktas, 2015). In the study conducted by Yavuz Mumcu and Cansiz Aktas (2015), researchers concluded that students' attitudes towards mathematics had a direct correlation to self-efficacy and academic performance of which teaching activities were identified an approach needed to prepare to overcome weaknesses in self-efficacy impacting achievement (Yavuz Mumcu & Cansiz Aktas, 2015).

Integrating a high-performance indicator on annual standardized testing, through an exceptional integration of mathematics into everyday life and other subject matter, and through parent and teacher recommendation can prove high beneficial for increasing self-efficacy of a student in mathematics. An approach found successful among secondary students is hands-on mathematics and science instruction through inquiry and activity-based methodology (Ekwueme, Ekon & Ezenwa-Nebife, 2015; Thompson, 2009). A study conducted by Ekwueme, Ekon and Ezenwa-Nebife (2015) used pre- and post-testing to assess students' understanding of basic mathematics and sciences concepts taught in the formal school curriculum. The results of the study uncovered that positive improvement was found (a) among the students' participation and academic performance level in mathematics and science activities, and (b) among the teachers' willingness to use interactive hands-on approaches while communicating mathematical and scientific concepts to the students (Ekwueme, Ekon and Ezenwa-Nebife, 2015). Researchers have found that instructional techniques that use computer technology, manipulatives, selfassessment, and make connections across multiple areas such as cooperative learning, have increased math scores and positive student self-efficacy (Thompson, 2009). On the other hand, lectures and drill worksheets of which are teacher centered-instructional techniques have not been shown to contribute to higher levels of student mathematics and science academic achievement (Ekwueme, Ekon and Ezenwa-Nebife, 2015; Thompson, 2009; Winn, Mi Choi & Hand, 2016).

Self-efficacy effect on mathematics and science academic performance. Historical and current education curricula primarily leverage word-problems to connect education concepts to everyday application. This attempt was a decent starting point; however, the reality is that it is not effective because the examples are too theoretical and not relatable to the student. Zollman (2012) found that within the affective domain, the identity of a student is developed as he/she recognizes achievable competencies through the realization of short- and long-term goals with emphasis on personal beliefs. In other words, the passion and dedication forms within a student which in-turn becomes the motivational drive to push through the tough educational concepts to gain STEM-literacy.

Research conducted by Abdullah, Halim, and Zakaria (2014) found that drilled memorization of mathematic concepts does not lead to numeracy−mathematical literacy. In fact, the key to effectively encouraging critical-thinking and problem-solving capabilities involves cultivating the appreciation for how mathematics is applied in everyday life. Research conducted by Abdullah (2014) which describes how mathematical word problem solving can lead to acquiring complex thinking and reasoning skills as an approach to raise numeracy among U.S. high school students. The National Center for Education conducts a quantitative study using the Program for International Student Assessment (PISA)−a system of international assessments to compare the outcomes of learning as students near the end of compulsory schooling from countries across the world–to assess and measure the performance of 15-year-old students in mathematics, science, and reading literacy every three years. The National Center for Education Statistics (2013) found that a quarter (26% in 2013; 23% in 2009) of U.S. high school students were not proficient in mathematics. It is disheartening that many U.S. students were unable to apply STEM subject education to tasks that are embedded in real-world contexts.

The quasi-experimental control group design conducted by Abdullah (2014) found that the most difficult obstacle to achieving problem-solving skills among students was self-regulation which involves metacognitive awareness and cognitive control, of which both were triggered by the lack of attention and interference of thinking. To overcome this challenge, literature suggests that visual representation approaches can help students to develop tendencies as they visualize the real-life purpose to the mathematical problem which will open the door to carefully interpreting the problem for an accurate solution. Today's students are the future workforce of the 21st century and unfortunately, for the most part, do not have the hard science and mathematics knowledge, skills or abilities to manage equitably in the technological 21st century workplace. In an experiential learning theory study conducted by ALQahtani and Al-Gahtani (2014), it was found that the learning style of students is tied to their understanding of self-identity and thereby increases teaching efficiency when experience is applied. Clear connections must be made to the real-world application of STEM education to help students identify with the problem or challenge at hand and reduce the amount of remedial training that is needed for students entering universities and joining the U.S. workforce.

Self-efficacy and socioeconomic status paradox. Researchers have investigated the paradox of self-efficacy and SES status because there have been correlations found among the two areas that can be leveraged for student achievement (Anyon, 2014; Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Bandura, 2002; Chan, 2011; Chu Chun, & Rice, 2012; Clickenbeard, 2012; Fenning & May, 2013; Wang et al., 2012). According to research studies, a student's self-efficacy can be impacted by the student's own performance in high school, such as test scores and GPA (Fenning & May, 2013; Wang et al., 2012). For example, positive correlations were found between general self-efficacy and students who achieved a higher level high school GPA (Fenning & May, 2013). Conversely, there is a desire for perfectionism among gifted students and if the high academic achieving students do not earn a perfect score on tests or graded assignments, studies have shown that gifted students may feel as though they failed (Wang et al., 2012). Additionally, if the gifted students are not intellectually challenged with the curriculum then interest will be lost (Rubenstein, Siegle, Reis, Mccoach & Burton, 2012). Researchers also found that for all students, included gifted, underachievement is the likely educational outcome of an unchallenging environment and will have a negative impact on self-efficacy (Andrzejewski, Davis, Bruening & Poirier, n.d; Hwang, Choi, Lee, Culver & Hutchison, 2016; Kustos & Zelkowski, 2013; MacPhee, Farro & Canetto, 2013; Sen, 2016; Walter, 2015; Wang et al., 2012).

The paradox of self-efficacy and SES status among academically gifted students in science and mathematics may be in-part due to the reinforced education received outside of the formal school setting. Researchers have found that the majority of student learning is received and reinforced through out-of-school settings from enrichment programs, clubs, summer camps, or parental involvement and other adult tutoring, however, students experiencing resource scarcity in low-SES communities, especially a high number of URMs according to the U.S. Bureau of Labor Statistics (2017) may not receive the same quality of education reinforce and out-of-school support as their peer group in the U.S. (Brown, 2016; Falk & Dierking, 2010; Mayes & Moore, 2016; Overton, 2015; Traphagen & Traill, 2014; Shankar & Kalil, 2013).

Socioeconomic Status in Education. For decades, the demographics of the U.S. were majority Caucasian/White and the average American consisted of middle-class with a median income-level. Recently, the U.S. population landscape has changed among students and is a clear indicator that the entire U.S. population is on the cusp of change. Historically, the workforce consisted of predominately Caucasian/White males but is now expanding diversely by ethnicity and gender diverse groups many of which come from low-socioeconomic status (SES) locations. The low-SES locations of which the future workforce talent is coming from elementary and secondary schools that feed into post-secondary institutions, many facing resource scarcity that impact educational outcomes.

The effects of socioeconomic composition of a school can have significant and long-term effects on student educational outcomes (Borman & Dowling, 2010; Perry, 2012). The linkage between educational outcomes and low-SES composite of school have origins traced back to legislation in Section 402 of the Civil Rights Act of 1964 that identified the shortage of available equal educational opportunities for individuals of diverse race, color, religion, and/or national origin in public educational institutions at all levels in the U.S. that led to a study that addressed the issue and resulted in a report by Dr. James Coleman (known as the Coleman Report) on equality of educational opportunity (Coleman et al., 1966). The Coleman report drew a nationally representative sample size of over 600,000 students and 60,000 teachers from over 4,000 schools. The Coleman report concluded that student background factors overwhelming explained the academic disparities by measuring family economic background, family educational background and interests, and student attitudes. The findings of the Coleman Report triggered requests for rigorous research analysis on the effects of student education outcomes in elementary and secondary school, which are pursued in the present day (Borman & Dowling, 2010; Perry, 2012).

Recent research has pursued the effect of school SES composition on educational outcomes and justifies an indication that SES has a long-lasting and significant impact on student achievement. In 2006, a trend analysis was conducted on a nationally representative study of 12th-graders to examine the AAP scores spanning across three decades of data that included mathematics and science scores in the U.S. from 1972, 1982, and 1992 (Konstantopoulo, 2006). The researcher controlled for individual student SES, gender, and race, then analyzed the effect of school mean SES in addition to a sequence of school structure variables such as AAP courses, school locale, school demographics, student attendance, dropout rates, college attendance rates, and college preparation courses. Findings were consistent with the Coleman Report indicating that achievement disparities can often be attributed to socioeconomic factors. Most of the variation (80-90%) in achievement scores were found across academic subjects and time, within schools. The school mean SES was a reliable predictor of student achievement. The U.S. Census Bureau provides a definition for low-SES based on poverty-level family income, which was defined as a family of four with less than $21,947 per year. In 2009, there were 15.5 million children under the age of 18 residing with families in the U.S. living in poverty (U.S. Census Bureau, 2018).

Resource scarcity for low-socioeconomic status groups. Bidwell (2015) reported the data from the Southern Education Foundation that found across the U.S. on average more than half of the students qualified for free or reduced-priced lunches (greater than 50% of students in schools spanning 21 states) which indicated that the majority of U.S. students lived in low-income families at the time of this study. Over the years, the middle-class has contracted and slow to grow in number. There are several challenges for low-income students, including scarcity of communities in poverty continue access to technology and materials for conducting projects in STEM areas. Unlike their peers, students from poor communities do not have parents that can afford to provide allowances or outright pay for summer camps and extra-curricular STEM competitions.

Students from low-income households have parents and guardians who work in an array of career fields, from service and labor workers to members of the U.S. Armed Services. An incoming annual salary for a soldier with a child and a spouse was $20,000 and in 2013, military families spent over $100 million dollars in food stamps at *commissaries*–military grocery stores (Pyke, 2014). Frequent relocations make it very difficult for a military spouse to remain employed and make it difficult for a family to build long-term equity through housing and grow a savings account. During a quantitative study conducted by Engel, Gallagher and Lyle (2010) there was a correlation found between a child's academic achievement in the DoD Education Activity schools, and a military deployment of a parent. Astonishingly, literature show that there were long-term impacts on academic achievement in subjects related to mathematics and science.

Many low-income students did not have access to numerous social activities, such as sports and trips, of which their peers in a higher economic class may have membership. Many STEM programs are offered to schools as subsidize program costs, but do not cover all program expenses. In most cases, the school, parent, teacher, or students must invest some of their own funds to participate in the STEM program which can become a barrier for student access. Making STEM programs affordable is not enough action to get students from low-income families to participate, especially in those families where each penny goes toward a physiological necessity such as food and shelter.

Socioeconomic status and ethnicity. Researchers have sought to pinpoint why SES and ethnicity are strong predictors of educational attainment findings and now have evidence that peer influencer effects and SES composite of schools create an environment impact an individual student's education achievement, aspirations, attainment, and persistence to learn (Alvarado & An, 2015; Palardy, 2015; Perry, 2012). The Federal data reported the 2014-2015 school year was the first year when the majority of school-aged children were racially diverse (NCES, 2015). This was a historical moment when the minority became the majority in schools. Underserved groups are simply those with unencouraged STEM talent that have substantially grown in number to reach the need of educational reform support. Additionally, the Office for Civil Rights (2012) reported the U.S. Department of Education data indicated between the years of 2009 and 2010, women represented the majority of degree-attained students for undergraduate (57.4%) and graduate (62.6%) degrees. These are indicators of the future U.S. workforce population demographics.

Research conducted by Roberts (2010) focused on the lack of access to STEM opportunities for diverse groups including women, disabled persons, and underserved ethnic groups. Roberts emphasized that STEM education opportunities should be made available for all student learners and criticized the specialized STEM school structures. Data showed that if the current trends continue, the proficiency gap in the sciences will widen between privileged and disadvantaged (Drew, 2011). Underserved groups and students from low-income households signify a reservoir of hidden STEM talent that needs to be nurtured. Likewise, it is important to consider the impact differences of STEM activities across public schools versus STEM activities in specialized schools that have the ability to fund their own initiatives and provide numerous opportunities to students of median to high-level income households. Roberts (2010), Engel, Gallagher & Lyle (2010), and the National Academies Press (2015) found that the way in which one retains STEM-literacy is found and developed throughout multiple areas of one's life shaped by environmental factors and shaped by opportunities.

Socioeconomic status and academic performance. Socioeconomic status has been found to have lasting impacts on a student's academic performance in a range of education outcomes to include postsecondary attainment, academic achievement, and learning (Jennings, Deming, Jencks, Lopuch, & Schueler, 2015; Konstantopoulos, 2006; Newton, 2010; Palardy, 2008), and attainment (Palardy, 2013; You & Nguyen, 2012). The low-SES impact on academic performance was not linked solely to the specific student in poverty. Researchers have found that the SES composite of the school in which the student attends effects all students' academic performance attending the school (Jennings, Deming, Jencks, Lopuch, & Schueler, 2015; Konstantopoulos, 2006; Newton, 2010; Palardy, 2013; You & Nguyen, 2012). Furthermore, separating high-, medium-, and low-SES schools influences students' career goals, educational ambitions, and reduces students' access to resources which effects college-readiness (Alvarado & An, 2015; Dupriez, Monseur, Campenhoudt, & Lafontaine, 2012; Legewie & DiPrete, 2014; Rowan-Kenyon, Perna & Steele, 2011).

Federal Policies to Support STEM Programs. Appropriately crafted federal STEM education and outreach policy is essential to ensure the U.S. workforce grows the STEM talent needed today to meet tomorrow's challenges. As discussed in this literature review, the demographic landscape is changing and the youth engagement in STEM must adjust to ensure a learning open-mindedness is achieved across all demographic groups to create a strong foundation in STEM leveraging self-efficacy. Organizational leadership and decision-makers were found as key change makers to providing students access to successful STEM opportunities through actionable learning methods that can lead to the development of a strong U.S. workforce. The entire U.S. economy revolves around technology development through skilled STEM-literate citizens; therefore, it is the responsibility of U.S. education leaders, policy makers, and relevant stakeholders to indoctrinate and codify the importance of STEM throughout the U.S. educational continuum to achieve workforce goals.

The Government Accountability Report (2011) found that STEM education and research programs increased worldwide competitiveness through STEM career preparation benefiting the education field through developing competent future leaders. With the new U.S. demographics of majority low-income and minority students, it is important for decision-makers to recognize that the historical path to a STEM career preparation may not engage the new U.S. population effectively. Providing a simple subsidy for STEM outreach programs will no longer meet demand signal programs in- and out-of-school. If students do not have a dollar to spare, then it will not matter how affordable the STEM program becomes because the student just cannot afford it and therefore, will not have access to it. Fully funded programs are needed to reach the low-income population. Access must be viewed as an important link to connecting students and parents with very few resources to open and free impactful experiences. Public parks and libraries provide access to all levels of income to enjoy the outdoors or read books. Public commodities should be considered untapped STEM education resources that can be leveraged to engage the low-income communities.

Federal STEM initiatives. The federal government reshapes investments and continues to invest billions of dollars in STEM education programs to gain an advantage in U.S. competitiveness in education and growth in economy through critical community and organization partnerships (Bedolla, 2012; Emrey-Arras, 2014; Government Accountability Office, 2018; Jang, 2016; Mcilvaine, 2015; Rooks & Richard, 2017). As competency requirements change for occupations, the review of STEM initiatives should continue to evolve, and rigorous assessment of return-on-investment should be considered based on STEM occupation requirements linked to education content. Federal STEM initiatives are invested through the U.S. STEM landscape and involve oversight layers at the Presidential Administration and federal layer, and multiple strategic, operational and tactical layers within the federal agency that operates the federal STEM program. Researchers have studied the link between federal STEM initiatives and workforce needs (Jang, 2016).

Across the Federal government each agency operates under authorities governed by their Agency or Department key lead personnel in-charge while coordinating with the Presidential Administration and federal STEM Committees that drive a coordinated STEM agenda across the federal government. The federal STEM coordination effort began in 2007 when the America COMPETES Act was enacted, which authorized numerous programs to conduct STEM education programs across the federal government (The America COMPETES Act, 2007). In 2010, when the Act was reauthorized, it required the Presidential Administration's Office of the Science and Technology Policy to create a committee of STEM education to serve as an interconnector for all federal agencies (The America COMPETES Reauthorization Act, 2015). The committee was named the Committee on STEM Education (CoSTEM) and resides under the National Science and Technology Council. The CoSTEM developed a charter, working groups, and issued a 5-year Federal STEM Strategic Plan.

With the Federal government, there are many STEM programs that provide education and outreach initiatives to youth in the U.S. Additionally, many programs across the federal government support youth with a secondary or tertiary STEM objective or have ad-hoc or small budgets of which do not meet STEM federal reporting requirements, and therefore may not be included in the overarching federal STEM inventory and interagency coordinating teams. The federal agency that has the largest number of scientist and engineers in its workforce the Department of Defense (DoD) of which in 2012, it the STEM occupations consisted of more than 46 percent of its workforce (National Assessment of Educational Progress, 2015). The Department of Defense (DoD) provides numerous STEM initiatives across its three (3) Military Components–*Department of the Army*, *Department of the Navy*, of which the *U.S. Marine Corps* is embedded, and *Department of the Air Force*–and at the oversight level in the *Office of the Secretary for Defense*, and numerous other Defense Agencies to meet Defense mission workforce education, outreach, and engagement needs. The DoD invests in numerous STEM programs and initiatives at the national and local levels working with many organizations from kindergarten through post-graduate level through in-school education programs to various out-of-school engagements.

Researchers have addressed the need for civics education with STEM and found the DoD's Junior Reserve Officers' Corps (JROTC) to be an effective program offered in high schools for providing civic education to youth, emphasizing core subject areas (including STEM), and preparing for college (Boyd Pitts, 2016; Gainous & Martens, 2012; Jamieson, 2013; Levinson, 2011; Mirra & Morrell, 2011). The JROTC program includes subject area development with interactive discussion, role models, and service-learning opportunities while providing exposure to military structure for students who may otherwise have few civics education and military exposure opportunities providing real-world practical application to subject-areas including STEM occupation connectedness (Dávila, 2014; Gainous & Martens, 2012; Loui, 2013; Mirra & Morrell, 2011; Rice, 2011).

The individual Defense Military Service Components, which include the Army, Navy, Air Force and U.S. Marines, have invested in STEM education, research, outreach and initiatives to address the unique mission-driven STEM workforce and outreach needs to foster a competitive national defense strategy. Researchers found that the Army, Navy and Air Force have initiated numerous programs from STEM outreach to specific research programs, of which some are jointly coordinated programs such as the Science and Engineering Apprenticeship Program (SEAP) which provides an opportunity for high school students to participate in research at a Department of Defense laboratory during the summer (Craig, Graesser & Perez, 2018; Lord, 2016). Within the Department of the Navy, the Office of Naval Research developed intelligent tutoring technologies to increase STEM literacy, improve the quality of mathematics education and science teaching, and expand STEM education and career opportunities (Craig, Graesser & Perez, 2018). The Department of the Army includes a portfolio of pipeline programs in the Army Education and Outreach Program (AEOP) where the Army continues its long tradition and strong commitment to the advancement of STEM education and literacy by leveraging its assets to include the research facilities, equipment, and technology, along with its workforce of scientists and engineers as mentors (Lord, 2016). The Air Force includes a variety of elementary through postsecondary STEM education and outreach programs to include leveraging Air Force Academy and communities such as the falcon telescope network to engage youth in STEM and a core Air Force capability area such as space (Gresham, Palma, Polsgrove, Chun, Della-Rose & Tippets, 2016). The Defense Department's STEM initiatives uniquely provide an interconnected Defense STEM portfolio of opportunities that effectively engage the public, including youth, parents and teachers, and future workforce generations in meaningful, real-world STEM experiences, competitions and paid internships. Moreover, the collaborative engagement fosters among education teachers and DoD's workforce of scientists and engineers who can serve as mentors in partnership with the community to further push the agenda of connecting STEM education to future occupations and competencies in meaningful ways (Jang, 2016).

Gaps between STEM education and the required occupation skills have been identified in industry, academia, and government (Dang & Nylund-Gibson; 2017). Therefore, educators acknowledge the need to connect STEM education to careers to better prepare students for their future occupations and improve the probability of postsecondary retention in STEM fields while reducing pipeline attrition (Falk & Dierking, 2010; Overton, 2015; Shankar & Kalil, 2013; Traphagen & Traill, 2014). As the landscape continues to change for future workforce needs due to technological discoveries and advancements, the growing interest in the skills needed for STEM disciplines will continue to rise (Jang, 2016). With the increased advancement in technology, expected occupation changes, and ever-changing federal budgetary fluctuations, it is important for the federal government to partner with organizations in STEM education and outreach programs to ensure sustainable plans can be formed to overcome sequestration and budget delays that could have devastating long-term impacts on programs.

Federal STEM partnerships in programs to promote STEM education are found across many government agencies. In DoD, the Civil Air Patrol (CAP) is a congressionally chartered, federally supported non-profit corporation that serves as the official civilian auxiliary of the United States Air Force of which its three statutory missions are aerospace education, emergency services, and the cadet program that serves over 23,000 cadets in squadrons across the U.S. supervised by a Board of Governors (Rooks & Richardson, 2017). CAP has recently been tasked with homeland security and courier service missions. The CAP also performs non-auxiliary missions for various governmental and private agencies, such as local law enforcement and the American Red Cross. The CAP program was established in 1941 as an organization by Title 10 of the United States Code and its purposes defined by Title 36.

Smaller and similar afterschool civic enrichment programs exists that the Defense Department endorses and could incorporate STEM curriculum into the existing program structures such as Young Marines, established in 1959 and administered by the Marine Corps League, and U.S. Navy Sea Cadets Corps (USNSCC), established in 1962 and managed by the Navy League of the U.S. supported by both the U.S. Navy and Coast Guard. The Young Marines program is a national youth organization serving 9,600 youth with 2,500 adult volunteers in 280 units across 46 states, the District of Columbia, Germany, Japan and affiliates in a host of other countries. The Young Marines program serves youth between 8 years old through high school graduation to strengthen the lives of American youth by teaching the importance of self-confidence, academic achievement, honoring veterans, good citizenship, community service, and living a healthy, drug-free lifestyle while focusing on character building and leadership development. The USNSCC is a national youth leadership development organization that promotes interest and skill in naval disciplines while instilling strong moral character and life skills through leadership and technical programs modeled after the Navy's professional development system (Mcilvaine, 2015). Comprised of two programs, the Naval Sea Cadet Corps (NSCC) program is for youth ages 13 through high school graduation, and also includes a junior program the Navy League Cadet Corps (NLCC), for youth ages 10 through 13 years of age (Mcilvaine, 2015). The USNSCC is designed to continues to further the image of our maritime services by adhering to a standardized training program designed to (a) develop an interest and ability in seamanship and seagoing skills, (b) instill virtues of good citizenship and strong moral principles in each cadet, (c) demonstrate the value of an alcohol-free, drug-free and gang-free lifestyle, and (e) expose cadets to the prestige of public service and a variety of career paths through hands-on training with our nation's armed services (Mcilvaine, 2015).

According to many research studies, school resources and, in particular, high school program offerings have been acknowledged as primary features of a school that affect postsecondary pathways leading towards college enrollment and STEM occupations. The features of a school are important to the continuation of postsecondary education and were found to be vital in the pursuit of STEM-related pathways, especially as one determines the choice of a major field of study (Domina, 2009; Dyce, Albold, & Long, 2013; Foust, Hertberg-Davis, & Callahan, 2009). The Federal initiatives invested in STEM education, outreach, and research opportunities provide resource support to U.S. communities in schools that have scarcity constraints that impact education outcomes. Stable and long-term resourcing was found to provide positive learning outcomes on schools with low-SES students and increase academic achievement through out-of-school programs provided by Federal STEM initiatives that connect the education lesson to real-world careers. A list of federal potential STEM partners for government across academia and industry can be found in Appendix D.

Summary

Over the past two decades, the education disparity has become more prevalent as minorities rise to the majority of the U.S. population and academic achievement gaps between URMs and non-URMs continue to widen while the labor force projections for STEM careers (U.S. Census Bureau, 2017; Andersen & Ward, 2014; Andrews & Stange, 2016; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Carnevale, Cheah & Hanson, 2015; Dang & Nylund-Gibson, 2017; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Stephens, Hamedani, & Destin, 2014; Suziedelyte & Zhu, 2015). Advanced academic curriculum can be costly to schools and students leading some low-SES populations to opt-out of the STEM courses due to the upfront and potential long-term costs that will impact the students' family budget (Walker & Pearsall, 2012; Castleman, Long & Mabel, 2018; Baum, Ma & Payea, 2013; Black, Lincove, Cullinane & Veron, 2015); however, the education benefits and potential long-term college cost savings that can be realized through the student's passed AAP test scores resulting in dual-college credit or shortening time to achieve college diploma (College Board, 2014b). Student self-efficacy was identified have an impact on student academic performance in mathematics and science in advanced placement preparation with regard to postsecondary education and career attainment (Ackerman, Kanfer & Calderwood, 2013; Astin & Oseguera, 2012; Dyce, Albold, & Long, 2013; Hwang, Choi, Lee, Culver & Hutchison, 2016; Konstantopoulos, 2006; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Sen, 2016; Shaw, Marini & Mattern, 2012;

Wang, 2013; Wang & Degol, 2013). Moreover, empirical evidence was found that URM participation in AAP have a higher success rate in college which determined that URM enrollment in critical STEM AAP courses provides a strong foundation for college preparedness and achievement (Alvarado & An, 2015; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Bryan, Glynn, & Kittleson, 2011; Martinez & Guzman, 2013; Miller-Cotto, & Byrnes, 2016; Negru-Subtirica & Pop, 2016; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Sadler, Sonnert, Hazari & Tai, 2014; Stipanovic & Woo, 2017).

The prevalence of education disparity between URMs and non-URMs and the increased demand for STEM occupations along with the growing population of URMs rising to the majority population, specifically the Hispanic/Latino population expected to comprise one-fifth of the labor force by 2026 remains a 21st century STEM education and diversity workforce crisis (Carnevale, Smith & Strohl, 2013; National Center for Education Statistics, 2012; Pew Research, 2016; U.S. Bureau of Labor Statistics, 2017; Vilorio, 2014). Research in STEM education has obtained many interesting discoveries, however, due to the technological advances in society and new national defense needs for future STEM careers, education is rapidly shifting to keep content relevant and engaging while meeting local, State, and Federal education requirements. Researchers have found that conducting STEM education and outreach programs using advanced STEM curriculum provides benefits to URMs in high school to be effective in postsecondary education; however, the stability resource for Federal STEM initiatives is important especially for the low-SES populations that may not otherwise enroll in the curriculum due to the cost (Ackerman, Kanfer & Calderwood, 2013; Mattern, Marini, & Shaw, 2014; Shaw, Marini, & Mattern, 2012; Siobhan, Mckillip & Smith, 2013; Sparfeldt, 2007; Government Accountability

Office, 2018). A list of federal STEM initiatives can be found in Appendix E and a list of Federal STEM authorities can be found in Appendix F.

Chapter 3: Research Method

This study employed a quantitative, causal-comparative (ex-post facto) quasi-experimental research method to answer effectively the research questions surrounding differences in self-efficacy and science, technology, engineering and mathematics (STEM) education outcomes between demographic groups through a national perspective theoretical framework (Vogt, 2006; Vogt et al., 2012). The purpose of this quantitative, causal-comparative (ex-post facto) quasi-experimental study was to examine the difference in self-efficacy and STEM education outcomes between underrepresented minorities (URMs) and non-URMs performance in high school education (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). The problem addressed in this study was that there is a lower amount of young URMs proficient in STEM who are prepared to enter STEM professions compared to their Asian and White (non-URMs) peers; specifically minority's high school youth who are largely in low-SES groups lack student proficiency and self-efficacy in STEM advanced academic (AAP) courses (Cannady, Greenwald & Harris, 2014; Lian, 2017; Martinez & Guzman, 2013; Noonan, 2017; Sadler et al., 2014). The research method chapter describes the research design, study population and sample, instruments, data collection and analysis, assumptions, limitations, and the ethical assurances of the study.

Research Questions

RQ1. What is the difference in self-efficacy and STEM education outcomes between URMs and non-URMs?

RQ1a. What is the difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs?

RQ1b. What is the difference in self-efficacy and science AAP test scores between URMs and non-URMs?

RQ1c. What is the difference in self-efficacy and computer science AAP test scores between URMs and non-URMs?

Hypotheses

$H1_0$. There is not a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1_a$. There is a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1a_0$. There is not a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1a_a$. There is a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1b_0$. There is not a statistically significant difference in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1b_a$. There is a statistically significant difference found in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1c_0$. There is not a statistically significant difference in self-efficacy and computer science AAP test scores between URMs and non-URMs.

$H1c_a$. There is a statistically significant difference found in self-efficacy and computer science AAP test scores between URMs and non-URMs.

Research Methodology and Design

The quantitative, causal-comparative (ex-post facto) quasi-experimental research design involved observing and testing the relationship of the variables and grouping differences utilizing readily quantifiable measures in a focused comparison research design (Vogt, 2006; Vogt et al., 2012). The design focused on the student questionnaires that were administered during the first year of the longitudinal high school study (HSLS:09) from 2009 through 2012 capturing 9th grade student self-efficacy and academic outcomes using STEM advanced placement scores to compare demographic groups using a regression discontinuity design (RDD). Regression discontinuity compared the differences in the average outcomes of groups and handles non-observable characteristics more convincingly than other quasi-experimental matching methods which deemed a useful design for the HSLS:09 variables under observation in this study (Maynard, Wing & Cook, 2013; Port, Unlu, Bloom & Cimpian, 2017). The HSLS:09 data were from a dynamic dataset that provides agility with comparing variables such as the examination of self-efficacy and educational outcomes in relative to high school advanced academic performance in mathematics, science and computer science.

Quantitative methods utilized elements of qualitative approaches specifically for those quantitative datasets such as the EDAT that contained qualitative HSLS:09 interview data that were included in this research study (Frels & Onwuegbuzie, 2013; Smith, 2015). A cross-sectional design was selected using matched comparison groups since the data involved naturally created groups with data collected at a single point in time used to address the research questions (Salkind, 2010). This research design was appropriate because it examined differences that existed in student achievement of student groups based on select comparison variables and observed characteristics to construct a comparison group using statistical techniques with demographic variables through an archival focused comparison research approach (Asamoah, 2014; Klugh, 2013; Salkind, 2010; Vogt, 2006, Vogt et al., 2012). In a causal-comparative inquiry, the researcher did not have the ability to control for extraneous or external variables which are not an issue for research study investigated (Kraska, 2010).

A quantitative research method was most appropriate for this study because the purpose of this study was to examine the difference between URMs and non-URMs with regard to the relationship between self-efficacy and STEM education outcomes (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). URMs compared to non-URMS including low-SES comparison score-rating strength for the implementation and evaluation components was represented in the predictor variables. Outcome variables included self-efficacy and STEM education outcomes. Scores for STEM advanced academic performance courses were measured across four mathematics tests, five science tests, and one computer science test. Other possible research designs were considered, but the causal-comparative (ex-post facto) quasi-experimental research was selected as the most appropriate for this study as it involves two distinct demographic groups being compared based on randomized group assignment (Asamoah, 2014; Klugh, 2013; Vogt, 2006, Vogt et al., 2012). Other potential quantitative research designs consisted of correlational and experimental research (Black, 1999; Vogt, 2006, 2010; Vogt et al., 2012).

The researcher excluded randomized experimental design because the study was based on an archival data retrieval method in which the variables were not able to be manipulated excluding a truly random sample process to occur (Asamoah, 2014; Klugh, 2013). Additionally, the focus of the study was on comparing demographic groups and not correlating other variables and therefore, the correlational design was excluded (Black, 1999, 2002; Vogt et al., 2012). The researcher did not undertake variable manipulation in the research study and thus, experimental and quasi-experimental designs were excluded (Asamoah, 2014; Klugh, 2013). Rather, observe characteristics to construct a comparison group using statistical techniques with demographic variables through an archival focused comparison research approach, deeming the causal-comparative (ex-post facto) quasi-experimental cross-sectional design the most appropriate (Asamoah, 2014; Klugh, 2013; Vogt, 2006, Vogt et al., 2012).

Population

The population for this study consisted of 21,444 students in U.S. high school courses offered in 2009. The student group in this population of interest included a randomized sample of the 9th grade high school student population within the U.S. and the District of Columbia who attended public and private school systems during the 2009 academic school year. Nearly half, 49 percent (N=10,557) of U.S. high school students in the population were female (NCES, 2018). Approximately, 69 percent (N=12,630) of the population were non-URMs while 29 percent (N=2,684) were URMs (NCES, 2018). Sixteen percent (N=3,516) of the population were from backgrounds with low-socioeconomic status (NCES, 2018). The population spanned ten of the 50 U.S. states, which included school districts in rural, urban and suburban locations and demographics to provide a representation of the nation's population. Students in Bureau of Indian Affairs (BIA) schools, Special Education schools for students with disabilities, schools without a 9th-grade class and other criteria were excluded from the study population because the HSLS:09 survey did not collect those data. The other criteria excluded from the HSLS:09 study were ineligible schools which had the following criteria: Bureau of Indian Affairs (BIA) schools; Special education schools for students with disabilities; Career technical education (CTE) schools that do not enroll students directly; Department of Defense (DoD) schools located outside the United States (OCONUS); Schools without both a 9th and 11th grade; schools not in operation during the fall of 2009; juvenile correction/detention facilities; other schools that address disciplinary issues but do not enroll students directly; ungraded schools (i.e., no metric to define students as being in the ninth grade); schools that only offer testing services for home-schooled students; and schools that did not require students to attend daily classes at their facility; students directly; ungraded schools (i.e., no metric to define students as being in the 9th grade); schools that only offer testing services for home-schooled students; and Schools that did not require students to attend daily classes at their facility.

Sample

The sample for the research study consisted of 8,056 students in STEM advanced academic placement (AAP) courses offered in high school in 2009. A stratified sample was drawn from the archival EDAT dataset to achieve the purpose of this study. The sample was comprised of students from different demographics (URMs and non-URMs) including low-SES to measure the level of self-efficacy and STEM AAP test score in 9th grade in 2009. The sample was determined by sorting all STEM AAP GPA data for students with (*X3TGPA AAP and IB*) and determine which scores indicated students had in fact taken a STEM AAP course by the numeric score placed in the EDAT data set of a positive numeric value instead of a negative numeric value in the SPSS dataset analysis. Over half, 55 percent (n=4,452) of U.S. high school students in the sample were female (NCES, 2018). Approximately, 72 percent (n=5,788) of the sample were non-URMs while 28 percent (n=2,268) are URMs (NCES, 2018). Eighty percent (n=6,414) of the sample were from backgrounds with low-socioeconomic status that are at or below the poverty threshold (NCES, 2018). The archival data were collected from the online public dataset of the Department of Education. The archival data consisted of data on 9th-grade students enrolled in high school in the public and private school system. Students enrolled in homeschool, BIA schools, vocational schools or special education schools were excluded from the sample. Stratified sampling was utilized to separate and to categorize the students by ethnicity/race, SES, self-efficacy, and STEM advanced academic test score.

A two-tailed alpha were set at 0.05, and power set at 0.95, based on a G*Power analysis with 8,056 students was needed for the sample from URMs and non-URMs who attended AAP mathematics and science courses in 2009 from HSLS:09 study in the EDAT data. There were four groups studied: (a) URMs and non-URMs who participated in STEM AAP courses with high AAP test scores and high self-efficacy; (b) URMs and non-URMs who participated in STEM AAP courses with high AAP test scores and low self-efficacy; (c) URMs and non-URMs who participated in STEM AAP courses with low AAP test scores and high self-efficacy; (d) URMs and non-URMs who participated in STEM AAP courses with low AAP test scores and low self-efficacy. Secondary archival data for Fall 2009 was obtained from an online data center called EDAT where the HSLS:09 survey data is housed of which the NCES conducted the survey on U.S. high school students providing a nationally representable large sample population of publically available data for accessibility.

Materials/Instrumentation

The quantifiable STEM education outcomes and self-efficacy data collected by the Department of Education during the academic school year 2009 through 2013 were utilized for the secondary analysis. The data obtained for this study were retrieved from a publicly available website source, the education data analysis tool (EDAT). The research instrument utilized for this study was the education data analysis tool (EDAT) which was used to collect numerous survey datasets, in particular, the high school longitudinal study conducted in 2009.

Education Data Analysis Tool (EDAT)

The research instrument utilized in for this study was the education data analysis tool (EDAT) which captured numerous survey datasets, in particular, the high school longitudinal study conducted in 2009. This quantitative study utilized data from the High School Longitudinal Study of 2009 (HSLS:09), which included data collected from high school freshman, sophomore, junior and senior students in 2009, 2010, 2011, and 2012 across the U.S. through a longitudinal study. In addition, follow-on surveys were conducted to collect data on postsecondary students in 2012, 2013, 2014, 2015 and 2016. The HSLS:09 survey conducted a national sampling that consisted of 944 schools and over 23,000 students, which captured race/ethnicity, socioeconomic status, and region providing a nationally representative sample representing the diversity of the American population.

The study sample, including all variables, means and standard deviations for all continuous variables, and frequencies and percentages for all categorical variables, were calculated using descriptive statistics (Fields, 2013). Multiple levels of data were included in the research study which is comprised of four separate categories that encompass the self-efficacy scale and involved data collection from students across an 8-year span beginning in their freshman year of high school across the U.S. and into postsecondary and workforce, which means that the data were embedded and complex.

High School Longitudinal Study of 2009 (HSLS:09)

Survey sampling strategy ensured that HSLS:09 provides data for a nationally representative sample. The reliability and validity of the EDAT online dataset tool were established from studies conducted by Department of Education (NCES, 2018). The HSLS:09 survey provides data regarding education outcomes, higher education completion, and employment. Additionally, information on potential youth academic outcome impacts was collected such as parent influencers, behavioral or disciplinary actions recorded, home life challenges, and history of times youth moved between schools was collected. The EDAT database included multiple data points of information collected from thousands of students using numerous education survey tools administered by the Department of Education across the U.S. Regression discontinuity design (RDD) provides an unbiased estimate of the treatment effect under relatively mild conditions and appropriate for this research study. Lee (2008) connected RDD to the traditional randomized experiments by creating testable conditions under which a non-random assignment treatment instrument shares the same components as the traditional randomized experiment. Construct validity was established through the analysis of test scores which showed consistency in numerous research studies as a repeatable construct method (Field, 2013). The coefficient of reliability (alpha) for the scale was .65.

Multiple scales of the EDAT dataset were utilized for this study, which included 17 HSLS:09 questions that assess implementation and evaluation components of self-efficacy, and STEM academic achievement outcomes. The HSLS:09 data were a dynamic dataset that provides agility with comparing variables such as the examination of self-efficacy and educational outcomes in relative to high school advanced academic performance in mathematics, science and computer science. The conceptual model created for this study was built on the assumption that high school advanced academic performance in mathematics, science and computer science is interconnected with postsecondary STEM education and workforce pathways (i.e., continued participation in STEM advance placement and initial field of study), self-efficacy, and educational outcomes while controlling for socio-demographic factors (Table 2). Since the study was focused on STEM-related self-efficacy and educational outcomes, the categories for field of study were derived accordingly in mathematics (e.g., *Mathematics and Computer Science, Calculus AB*, *Calculus BC,* and *Statistics*), science (e.g., *Biology, Environmental Science A, Physics B, Physics C-electronic,* and *Physics C-mechanic*), computer science (*Computer Science A*), or non-participation (e.g., non-STEM or non-AAP). Although the two type of outcomes (i.e., participation and test scores in STEM fields of study AAP exam, continued enrollment in AAP course as educational attainment, and self-efficacy while controlling for socio-demographic factors. The hypotheses were formed under the opus that a strong STEM education foundation acquired in high school through engagement in the advanced curriculum can reduce the academic gap between URMs and non-URMs, including low-SES, in STEM. And consistent with Bourdieu's assumptions of capital creation within membership networks and social structures, the conceptual models focus on the effect of student's background and demographic characteristics as the independent variables shown in the individual characteristics column.

Table 2

Conceptual Model of Self-Efficacy and Educational Outcomes

<table>
<tr><th>Individual Characteristics</th><th>High School Self-Efficacy</th><th>High School Advanced Academic Placement (AAP) Course Exam Grade</th><th>Outcomes</th></tr>
<tr><td rowspan="11">1. Race/ethnicity
2. Socioeconomic Status (SES)</td><td rowspan="5">Scale of student's mathematics self-efficacy (X1MTHEFF):
9th grader confident can do excellent job on fall 2009 math tests (S1MTESTS)
9th grader certain can understand fall 2009 math textbook (S1MTEXTBOOK)
9th grader certain can master skills in fall 2009 math course (S1MSKILLS)
9th grader confident can do excellent job on fall 2009 math (S1MASSEXCL)</td><td>Mathematics and computer science AP (X3TXAPMATCOM)</td><td rowspan="11">1. Academic Performance in AAP STEM education and self-efficacy correlation

2 GPA for all academic courses in 9th grade (X3TAGPA09)

3. GPA for all academic courses in 12th grade (X3TAGPA12)</td></tr>
<tr><td>Statistics (X3TXAPSTATS)</td></tr>
<tr><td>Calculus AB (X3TXAPCALCAB)</td></tr>
<tr><td>Calculus BC (X3TXAPCALCBC)</td></tr>
<tr><td>Computer science A (X3TXAPCOMSCI)</td></tr>
<tr><td rowspan="6">Scale of student's science self-efficacy (X1SCIEFF):
9th grader confident can do excellent job on fall 2009 science tests (S1STESTS)
9th grader certain can understand fall 2009 science textbook (S1STEXTBOOK)
9th grader certain can master skills in fall 2009 science course (S1SSKILLS)
9th grader confident can do excellent job on fall 09 science (S1SASSEXCL)</td><td>Biology (X3TXAPBIO)</td></tr>
<tr><td>Chemistry (X3TXAPCHEM)</td></tr>
<tr><td>Environmental Science (X3TXAPENVSCI)</td></tr>
<tr><td>Physics B (X3TXAPPHYB</td></tr>
<tr><td>Physics C (X3TXAPPHYELE)</td></tr>
<tr><td>Physics C (X3TXAPPHYMEC)</td></tr>
</table>

Operational Definitions of Variables

The main constructs related with this study are non-underrepresented minorities (non-URMs), self-efficacy, STEM advanced academic placement (AAP) curriculum exam scores, student socioeconomic status (SES), and underrepresented minorities (URMs). Non-underrepresented minorities, URMs, STEM AAP curriculum exam scores and student SES were all categorical variables, while self-efficacy measured in mathematics and science were composite/ratio variables.

Non-Underrepresented Minorities (URMs). The non-underrepresented minorities (URMs) variable was an independent variable that includes the participant from (a) Caucasian/White populations and/or (b) Asian populations. The definition of the variable was used from NCES terminology of race/ethnicity categorization in the HSLS:09 of which the respondent self-identified with the population group. A person from a white population is one having origins in any of the original peoples of Europe, the Middle East, or North Africa. A person from an Asian population was a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam (NCES, 2018).

Self-Efficacy. Self-efficacy is measured separately for science and mathematics. Self-efficacy was operationally defined by individual student in the following four areas as follows: (a) 9^{th}-graders confidence to do an excellent job on math and science tests, (b) understanding of math and science textbooks, (c) certainty of mastering skills in math and science in courses, and (d) confidence in math and science assignments in fall 2009. Within the HSLS:09 survey there were a total of 10 scales created from the student responses across mathematics and science self-efficacy (NCES, 2018). The two self-efficacy variables observed in this study included the mathematics self-efficacy and the science self-efficacy rolled-up composite variables. The mathematics self-efficacy variable was a scale of the sample member's mathematics self-efficacy which included higher X1MTHEFF values represented in higher mathematics self-efficacy. Likewise, the science self-efficacy variable of the sample member's science self-efficacy included higher X1SCIEFF values represented in higher science self-efficacy. Both mathematics and science self-efficacy variables were separately created through principal components factor analysis (weighted by W1STUDENT) and standardized to a mean of 0 and standard deviation of 1. There were multiple inputs to this scale to pre-set NCES (2018) measure of self-efficacy (e.g., identity, utility, interest, engagement, and belonging). Only respondents who provided a full set of responses were assigned a scale value. If the student indicated that he or she was not taking a fall mathematics or science course, this variable is set to -7.

STEM Advanced Academic Placement (AAP) Curriculum Exam Scores. Advanced Academic Placement (AAP) STEM curriculum provides high school students access to college-level coursework while in high school in one on the following accredited subject areas: *Biology, Calculus AB, Calculus BC, Statistics, Chemistry, Computer Science A, Engineering, Environmental Science AP, Mathematics and Computer Science, Physics B, Physics C-electronic,* and *Physics C-mechanic*.

Student Socioeconomic Status (SES). A socioeconomic status variable was created for subpopulation definition and as an independent or control variable for URMs in the current study. Socioeconomic status was measured by a composite variable calculated using family income, parental educational attainment, or parental occupation according to definitions from NCES (2018). Student SES was a social status construct represented by an index in HSLS:09

and it took into account a student's home background as represented by parent's education, parent's occupation, and family income which is available on the EDAT. The first HSLS:09 SES index was created specifically for HSLS:09 by NCES (2018) and includes a covariate adjustment based on the school locale composite variable (city, suburban, town, or rural locale).

Underrepresented Minorities (URMs). The underrepresented minorities (URMs) variable was an independent variable that includes the participant from (a) African American or Black populations and/or (b) Latino or Hispanic populations. The definition of this variable was used from NCES terminology of race/ethnicity categorization in the HSLS:09 of which the respondent self-identified with the population group. A person from an African American/Black population is one having origins in any of the black racial groups of Africa. A person from a Latino/Hispanic population was a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture, origin, or ethnicity regardless of race. Race/ethnicity was obtained for sampling purposes from administrative records provided by the School Coordinator (NCES, 2018). Race/ethnicity, SES, self-efficacy, and academic achievement were measured and categorized as shown in Table 3.

Table 3

A Demographic Perspective on Self-Efficacy and STEM Outcomes: Variables and Constructs

Variable/Construct Name	Type/Level of Measurement	Categories
Socio-demographic characteristics:		
Race/Ethnicity	Categorical 1-category variable 2-category variable 3-category variable 4-category variable	1 = White (1XWHITE) 2 = Black/African American (1XBLACK) 3 = Hispanic (1XHISPANIC) 4 = Asian/Hawaii/Pac. Islander (1XASIAN)
Socioeconomically status (SES)[1]	Categorical 1-category variable	1 = First quartile (lowest) 2 = Second quartile (middle) 3 = Third quartile (highest)
Self-Efficacy:		
Scale of student's mathematics self-efficacy (X1MTHEFF)	Composite/Ratio	1 = low 2 = high
Scale of student's science self-efficacy (X1SCIEFF)	Composite/Ratio	1 = low 2 = high
Academic Achievement:		
AAP exam: Mathematics and computer science (X3TXAPMATCOM)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Statistics (X3TXAPSTATSCOM)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Biology (X3TXAPBIO)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Calculus AB (X3TXAPCALCAB)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Calculus BC (X3TXAPCALCBC)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Computer science A (X3TXAPCOMSCI)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Environmental Science (X3TXAPENVSCI)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Chemistry (X3TXAPCHEM)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Physics B (X3TXAPPHYB)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Physics C-electrical (X3TXAPPHYELE)	Categorical	1 = AAP 2 = Non-participant
AAP exam: Physics C-mechanical (X3TXAPPHYMEC)	Categorical	1 = AAP 2 = Non-participant

Note: [1]SES is a composite variable of family income, mother/father highest education, mother/father occupation (NCES, 2018).

Study Procedures

The study received approval from Northcentral University's Institutional Review Board (IRB) prior to data collection. The confidentiality of the human subjects was achieved by utilizing the pre-categorized student variables within the NCES (2018) dataset that was publicly available and categorized variables in such a manner to protect identities and personally identifiable information (PII) of the students through connected identifiers across data points or directly. Therefore, anonymity was achieved, and the study had absolutely no probability of causing risk to participants. In accordance with IRB requirements, data was securely stored on a password-protected system with limited user access.

This study utilized quantitative methods to determine whether the level of student self-efficacy and participation in 9th grade STEM advanced academic placement (AAP) course influence underrepresented minorities (URMs) STEM education outcomes compared to non-URMs performance in STEM AAP test scores. Since the data were publicly accessible through EDAT (NCES, 2018), the values of the results are reproducible by using the identical procedures, collection, and statistical analyses provided in this quantitative, causal-comparative (ex-post facto) quasi-experimental research study design. The Institute of Education Sciences (IES) at the National Center for Education Statistics (NCES) holds a data center and within it exists a data collection tool called the education data analysis tool [EDAT] located at https://nces.ed.gov. The EDAT is an online tool that is utilized to hold and analyze multiple survey datasets, including the High School Longitudinal Study of 2009 (HSLS:09) data that was utilized for this study. The EDAT data center houses the HSLS:09 survey data used in this study and permits users to distinguish variables of significance by selecting *Student file* population of analysis on one or multiple variables by *composite*, *instrument, weights,* or *high school transcript.* Additionally, users were able to tag files and download information to statistical software data files for analytic purposes.

Data Collection and Analysis

Data collection for this study utilizing EDAT were gathered and were publicly available without any limitations. The NCES (2018) documented the HSLS:09 longitudinal study using EDAT and categorizes variables in such a method to protect identities and personally identifiable information (PII) of the students through connected identifiers across data points or directly. Therefore, this study had absolutely no probability of causing harm to any student in the sample 9th grade population analyzed. Since 1984, NCES has conducted five education longitudinal studies that included collecting data regarding high school students and schools, which gathered data in unique areas of the individual longitudinal study and included basic education outcomes key areas: faculty/staff, students/headcounts, courses, curriculum, student outcomes, socioeconomic status, race/ethnicity, gender, and student services. Student outcomes presented under the following specifics with a high level of self-efficacy and high grades in STEM advanced academic placement (AAP) courses. Since the data were collected by an external source, and not collected by this researcher, it was considered secondary data.

Archival data retrieved from the HSLS:09 from EDAT was compared between the level of student self-efficacy and STEM AAP test score between URMs and non-URMs in the 9th grade of the academic year 2009. Information was solely obtained from EDAT. A multivariate analysis of variance (MANOVA) analysis with a Poisson regression was utilized to reveal whether the level of student self-efficacy and participation in 9th grade STEM AAP course influence URMs STEM education outcomes compared to non-URMs performance in high school STEM AAP test scores. A Poisson regression analysis was used to reveal whether the individual self-efficacy levels have a statistically significant effect on STEM education outcomes for URMs. A Kolmogorov-Smirnov Test was conducted to ensure data assumptions were met to execute a valid Poisson regression (Laerd, 2015).

Data were downloaded from EDAT into SPSS version 23 for Windows and analyzed with a categorized linear modeling to minimize flawed assumptions and the influence of the statistical software package. A descriptive statistical analysis was performed and a multivariate analysis of variance (MANOVA) was utilized to test the null hypotheses and alternative model of this study, by examining if a significant relationship existed between the predictor variables and the multiple dependent outcome variables. The MANOVA statistical analysis was utilized to examine if increased self-efficacy levels in URMs, including low-SES, compared to non-URMs can statistically predict the STEM advanced academic test scores of the demographic group's STEM education outcomes.

Data Processing

Originally, the initial number of AAP courses obtained in the dataset included basic mathematics and science; however, there were variations across the U.S. for the types of mathematics, science and computer science AAP courses therefore each AAP course was reviewed and all courses that met the category of mathematics, science and computer science were included with the sample dataset. The data included type of course, self-efficacy results for mathematics and science, demographics, and SES in the sample obtained from the EDAT dataset which resulted in a sample size of 8,056 high school students in 2009 across 944 U.S. high schools. The high school data was disaggregated, not collected for this study, and not relevant for the research questions addressed in this study therefore was not collected. No STEM AAP courses were excluded from the analysis because of limited quantity of data available in the dataset as advanced placement or gifted courses were a small percentage of a school population. Additionally, no high school completion categories were excluded from the analysis to ensure all paths for high school students to enter the next phase of education or career pathway were analyzed, including students who dropped out of high school.

Assumptions

The population for this study consisted of students in STEM AAP courses offered in high school in 2009. It is assumed the STEM AAP courses chosen for this study met the appropriate criteria for a defined STEM AAP curriculum course. It is assumed equivalent curriculum was offered in the STEM AAP course across the U.S. locations surveyed and that teachers were appropriately trained for STEM AAP curriculum instruction. The participants were the students in identical STEM AAP courses taught across the U.S. and were assumed to be comparable in many factors such as grade level, education proficiency level, and demographic background. Moreover, the assumption was made that the number of sample participants (n=8,056) was sufficient to detect any existing significant relationships (Buchner, Erdfelder, Faul, & Lang, 2012). The assumption was made that the appropriate methodology for this research study a causal-comparative (ex-post facto) quasi-experimental quantitative research (Cozby & Bates, 2014; Dong & Maynard, 2013; Jackson, 2012; Szyjka, 2012). Further, the assumption was made surrounding the dependent variable of student self-efficacy is a ratio score, evenly distributed with no overlap between samples (i.e. a student can only have one self-efficacy level for math and one self-efficacy level for science). Another assumption included that the archival data obtained from EDAT holds fundamentally no data entry errors. Finally, the assumption was made that the populations from which the sample was obtained from are normally distributed and that the variances of the populations are equal.

Limitations

The causal-comparative (ex-post facto) quasi-experimental methodology was limited as it can only find causality with a fixed range of variables that already been collected and cannot be manipulated (Kim & Steiner, 2016). This research study was limited to archival data because of the advantages of utilizing prearranged surveys and existing data collection tools. For example, researcher bias is eliminated with building the survey instrument and implementing the data collection (Eckles & Stradley, 2012). This study was limited to students who participated in the HSLS:09 longitudinal study which contains aging data and as the next generation continues to become more diverse in demographics and self-efficacy factors may change, the study data can quickly become outdated.

Data items were limited by what was included in the existing HSLS:09 longitudinal study EDAT dataset; therefore, the researcher cannot select new test items, nor alter the instrument. The underlying dataset was wide-ranging with over 21,000 variables which will not unnecessarily limit the overall study. However, the limitation did mean that the researcher could not specifically select items to be tested. Additionally, the self-efficacy variables were self-reported and can have limitations of its own within validity (Walter, 2015). Self-reporting can be flawed (Walter, 2015; Kustos and Zelkowski, 2013) because the state of one's mind can be impacted by one's mood during that moment resulting in a change that cannot be detected within a study. Whereas test scores are accurate reflections of performance comparative on the same instrument; furthermore, it is worth noting that a broad national dataset that is deemed appropriate for studying the connection between self-efficacy and STEM education outcomes across demographic groups in high school (Walter, 2015; Kustos and Zelkowski, 2013).

Possible limitations to the study include the sample selection within the archival data, the specific demographic groupings from which participants were drawn, and variances that occur in high schools in class sizes, instructional time, quality of teachers and extracurricular activities students receive in mathematics and science at the school. The selection data were randomized according to the NCES (2018) data that was collected in a randomized controlled study with population participants were from intact classrooms that pre-existed. Within causal-comparative quasi-experimental research, the non-randomness of the sample can be a weakness because it did not guarantee that the two groups are equal. All variables in the HSLS:09 EDAT dataset NCES (2018) for URMS and non-URMs on self-efficacy and STEM AAP test scores were used for the sample in this research study, except for some missing data from the Asian demographic that was suppressed data. Every effort was made to keep the dataset true to the framework and the randomized nature of the HSLS:09 longitudinal study by using all variables within the subgroup analyzed, even if data were suppressed and missing of which was only the case for the Asian demographic variable.

Delimitations

The delimiting factors included (a) research problem and phenomenon, (b) research design, (c) purpose, (d) theoretical framework, (e) research questions, and (f) sampling method. This study was limited to one sampling time frame of archival public data retrieved from EDAT, and findings were limited to STEM education outcomes. The study was also delimited to students in STEM AAP mathematics and science courses offered in 9th grade in Fall 2009. Since numerous high schools were included in the nationally represented HSLS:09 longitudinal study and will be included in the study of the sample group, the results can be generalized nationwide across the U.S. External validity was limited in some ways by the narrow focus on students participating only in STEM AAP courses. However, a G*Power analysis was utilized to calculate the sample size. Expanding the STEM course subjects for all URMs and non-URM participants involved is beyond the range of this study and is not feasible given the resources and time available.

Ethical Assurances

The EDAT data center houses the HSLS:09 survey data used in the current study and permits users to distinguish variables of significance by selecting variables by type and downloading the variables for analytic practices. The data obtained for this study were publicly available from EDAT. The NCES (2018) documented the precautions taken to protect the data through categories. There were pieces of the data that were restricted by NCES, however, those data were not used in this study. Therefore, this study has no probability of causing harm to students who participated in the study. For example, the sample was derived from the existing publically available population data and was determined by sorting all STEM AAP GPA data for students by their coded identifiers using the GPA for the AAP and IB combined test scores (*X3TGPA AAP and IB*) to determine which scores indicated students had in fact participated in STEM AAP course by evaluating the numeric score used in the EDAT data set of a positive numeric value instead of a negative numeric value in the SPSS dataset analysis.

Using the sample dataset assures respect for persons by acknowledging autonomy and protecting with diminished autonomy using the identified codes that were provided in the existing dataset. The research study met each standard of the Belmont Report (2014) which includes the fundamental elements of (a) respect for individuals as autonomous agents while protecting each participant, (b) maximize the potential benefits and minimize the potential risks to participants in the study which go beyond the minimum of no harm caused to participants, and (c) distribute the benefits and risks of research equally among those who may benefit and ensure justice is born equally across members of society with the results of the research. The beneficence of student data was carefully managed by ensuring the maximum possible benefit could occur through the use of this research with minimum possible harm by password protecting the data and maintaining a strategic view of the analysis keeping personal identifiable information out of the dataset. Justice was carefully balanced by taking a random sample of students in the NCES EDAT population dataset of over 21,000 students and then selecting those who participated in in 9th and 12th grade overall GPA test scores with or without AAP test scores. This resulted in a sample of 8,056 student archival data in the dataset for analysis. A modified version of the IRB approval was required as no primary data was collected.

Summary

Quantitative methods were appropriate for investigating characteristics of a group to determine causal relationships and clarify predictions within populations (Kim & Steiner, 2016; Szyjka, 2012). The purpose of this research study was to examine the difference in self-efficacy and STEM education outcomes between underrepresented minorities (URMs) and non-URMs performance in high school education (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). This study pursued to determine whether the level of student self-efficacy and participation in 9th grade STEM advanced academic placement (AAP) course influence URMs STEM education outcomes compared to non-URMs performance in STEM AAP test scores. Therefore, a causal-comparative (ex-post facto) quasi-experimental design was utilized (Kim & Steiner, 2016).

Chapter 4: Findings

The purpose of this quantitative, causal-comparative (ex-post facto) quasi-experimental study was to examine the difference in self-efficacy and STEM education outcomes between URMs and non-URMs (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). Self-efficacy was measured in terms of a separate composite metric scale for a student's mathematics self-efficacy and science self-efficacy of which student self-belief, self-regulation, self-evaluation, self-stimulation, and self-monitoring of mathematics and science was measured for students who provided a full set of responses in the NCES HSLS:09 survey (Arlsan, 2016; Sen, 2016). The predictor variables consisted of URMs, to include participants who are African American/Black and Latino/Hispanic, including participants from low-SES, and non-URMs. The non-URM population sample included participants who are Caucasian/White and Asian. Underrepresented minorities (URMs) were also referred to as minority populations and were defined in this study as member's race/ethnicity characterized by two dichotomous composite variables, *African American/Black*-composite or *Latino/Hispanic*-composite demographics. This chapter discusses the study findings and evaluation of findings in a descriptive format in addition to tables which include student population and descriptive findings, instrumentation and reliability, investigation of assumptions as relates to inferential analysis, and tests of hypotheses presented using the SPSS tool version 23. All inferential analyses were tested at the 95% level of significance. The research question for this study was:

RQ1. What is the difference in self-efficacy and STEM education outcomes between URMs and non-URMs?

RQ1.a. What is the difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs?

RQ1.b. What is the difference in self-efficacy and science AAP test scores between URMs and non-URMs?

RQ1.c. What is the difference in self-efficacy and computer science AAP test scores between URMs and non-URMs?

Hypotheses

$H1_0$. There is not a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1_a$. There is a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1a_0$. There is not a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1a_a$. There is a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1b_0$. There is not a statistically significant difference in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1b_a$. There is a statistically significant difference found in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1c_0$. There is not a statistically significant difference in self-efficacy and computer science AAP test scores between URMs and non-URMs.

$H1c_a$. There is a statistically significant difference found in self-efficacy and computer science AAP test scores between URMs and non-URMs.

A cross-sectional design was selected using matched comparison groups to test the relationships between the predictor variables, URMs, non-URMS, self-efficacy, socioeconomic status (SES), and the criterion variable, STEM education outcomes, and the sampling set included the archival records of 8,056 high school student records for the 2009-2013 academic year across the U.S of which the data involved naturally created groups with archival data collected at a single point in time used to address the research questions. A descriptive statistical analysis was performed and a multivariate analysis of variance (MANOVA) was utilized to test the null hypotheses and alternative model of this study, by examining if a significant relationship exists between the predictor variables and the multiple dependent outcome variables. A statistical description of the measurements collected was presented, along with the results, an evaluation of the findings, and a summary.

Validity and Reliability of the Data

The reliability and validity of the EDAT online dataset tool were established from studies conducted by Department of Education (NCES, 2018). The HSLS:09 survey provided data regarding education outcomes, higher education completion, and employment. Additionally, information on potential youth academic outcome impacts was collected such as parent influencers, behavioral or disciplinary actions recorded, home life challenges, and history of times youth moved between schools was collected. The EDAT database included multiple data points of information collected from thousands of students using numerous education survey tools administered by the Department of Education across the U.S. Regression discontinuity design (RDD) provided an unbiased estimate of the treatment effect under relatively mild conditions and was appropriate for this research study. Lee (2008) connects RDD to the traditional randomized experiments by creating testable conditions under which a non-random assignment treatment instrument shared the same components as the traditional randomized experiment. Construct validity was established through the analysis of test scores which has shown consistency in numerous research studies as a repeatable construct method (Field, 2013).

Results

A concise explanation of the data collection process and description of the demographic information of the archival data were captured of which comprised the results section and included participant with in this study. The dependent variable was at least interval and the p value generated was 0.00 indicating a statistically significant result (Laerd, 2015). A Poisson regression was used as the statistical test for this study. The assumptions of regression and the statistical test that was performed were identified followed by the reporting of the results specific to each research question and related hypotheses.

Study results were based on students in advanced academic placement (AAP) science, mathematics and computer science courses offered across the U.S. in Fall of 2009 and education outcomes of Spring of 2012 in the form of EDAT. In 12th grade is when the third wave of the HSLS:09 data collection occurred and, in Spring of 2012 is when the 12th grade students were in their final year of high school graduation. The second data point allowed for the STEM education outcome measurement of this study. Data was obtained from the DataMart database for the periods of Fall 2009 and Spring 2012. There were two groups studied in the dataset, URMs and non-URMs, to assess the student's self-efficacy and academic performance in AAP courses as having a potential influence on STEM education outcomes.

Demographic characteristics. Characteristics of the sample students in the EDAT dataset enrolled in U.S. high schools in 2009 through 2013: 55% female, 45% male, 13% Hispanic/Latino, 6% African-American/Black, 15% Asian (non-Hispanic/Latino), 9%

Multiracial, 0.3% American Indian/Alaska Native, 0.5 % Hawaiian/Pacific Islander, 55% Caucasian (NCES, 2018). The demographics analyzed were African American/Black, Latino/Hispanic, Asian, and Caucasian groups. The initial number of students in the URM group obtained was 1,941 students to include African American/Black, Latino/Hispanic (no race specified), and Latino/Hispanic (race specified). However, the parameters if the data set for this study included non-Hispanic/Latino (more than one race specified) which added another 668 URM students to the dataset. Prior to the analysis, the data were examined for outliers and missing cases within the fields. The delineation of URMs and non-URMs allowed for deep analysis to understand why the URMs are lagging behind their non-URM peers in STEM and addressed potential solutions to resolve the issues revealed in the data findings.

Descriptive statistics analysis of study variables. Data were gathered from the archival records for the 2009-2013 academic high school year from the EDAT national database containing AAP test score data from the High School Longitudinal Study of 2009 that encompassed over 23,000 pieces of data nationwide across the U.S. (NCES, 2015). The final sample of archival student records from the randomized, multiple school student sample set which represented 35% (n=8,056) of registered high school students in the U.S. which was a rigorous sample size based on a G*Power analysis and reflected the target population of over 23,000 student records across 944 schools within the EDAT records site across the U.S. for the academic period from 2009-2013 for the purposes of the longitudinal study conducted in 2009 by the Department of Education (NCES, 2015). Furthermore, the sample analysis consisted of 45% female (n=3,604) and 55% male (n=4,452) students of which approximately 6% were African American/Black, 15% were Asian (non-Latino/Hispanic), 13% were Latino/Hispanic, 9% were non-Hispanic/Latino (more than one race specified), and 55% Caucasian (non-Latino/Hispanic) demographics. Students who selected American Indian/Alaska Native and Hawaiian/Pacific Islander demographics were 0.3% and 0.5% of the sample respectively. The purpose of the study was to gather data to allow the researcher to examine the difference in self-efficacy and STEM education outcomes between underrepresented minorities (URMs) and non-URMs performance in high school education (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). A quantitative approach with a descriptive nature of the study was provided for gathering data.

The data set was analyzed for all dependent and independent variables including measures of central tendency. For self-efficacy in science, the mean scores for the multiple variable findings to appear in the URMs of which included the African American/Black composite student group (M = -2.3654; SD = 3.68493) and the Latino/Hispanic composite student group (M = -5.2861, SD = 3.65437). For self-efficacy in mathematics, the results were similar however, the mean scores for both URM groups reduce of which include the African American/Black composite student group (M = -1.7131; SD = 3.46700) had a significant decline in mean score and the Latino/Hispanic composite student group had a slight decline (M = -5.0832, SD = 3.80571). There was no difference in the Caucasian/White composite group score data across the science and math self-efficacy scores. Table 4 summarizes the descriptive statistics (mean and standard deviations) of the dependent and independent variables.

Table 4

Descriptive Analysis: Study Variables

Variable	*N*	*M*	*SD*
Self-Efficacy in Science			
African American/Black composite	2,653	-2.3654	3.68493
Hispanic/Latino composite	422	-5.2861	3.65437
Asian composite	---	---	---
Caucasian/White composite	881	0.0000	8.0000
Self-Efficacy in Mathematics			
African American/Black composite	2,653	-1.7131	3.46700
Hispanic/Latino composite	422	-5.0832	3.80571
Asian composite	---	---	---
Caucasian/White composite	881	0.0000	8.0000
Advanced Academic Placement (AAP) STEM GPA			
African American/Black composite	23,503	-.06	1.451
Hispanic/Latino composite	23,503	-.22	1.892
Asian composite	23,503	0	-5.00
Caucasian/White composite	23,503	.51	1.451

Note. *N* = Sample Size; *M* = Mean; *SD* = Standard Deviation.

Descriptive statistics and analyses. To examine the difference in self-efficacy and STEM education outcomes between URMs and non-URMs (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016), this study examined publicly available data from the first (2009) and third (2012) waves of the High School Longitudinal Study of 2009 (HSLS:09). Publicly available data consisted of nationally representative quantitative information from high school students as well as their teachers, parent influencers, classrooms and schools that was publicly available in the public-use dataset. The first wave of the public-use dataset included data from 9th grade students in 2009 encompassing over 23,000 pieces of data from a random sample of 944 public and private schools. The first follow-up wave of the HSLS:09 was representative of the previous 9th grade cohort students whom were in the 12th grade and are now in either in graduate school or in the workforce at the time of this study (Dalton, Ingels, Fritch, NCES & RTI, 2016).

Using the electronic code book software program designed by the U.S. Department of Education (NCES, 2018), the extraction of publicly available data included information from 23,503 students clustered in 944 schools. The publicly-available data drawn included individually coded public-use composite variables created by NCES to identify student characteristics, levels of self-efficacy, demographics or education. The National Center for Education Science categorizes student's race/ethnicity as Latino/Hispanic, African American/Black, Caucasian/White, Asian/Pacific Islander, and many others using a series of multiple dichotomous composite variables that cross-reference school, student, and parental influencer/family provider data sources. For coding and data organization, estimation procedures for missing data, such as multiple imputation, were not use in this study. Variables were recoded to exclude missing values to ensure analysis of cases with only completed data were reviewed. As a result, students were recoded as Latino/Hispanic (race not specific) and Latino/Hispanic (race specific) were grouped into the same category. The general linear model of the between-subject factor data shown in Table 5.

Table 5

Between-Subjects Factors

Subjects	N
Student is African American/Black-composite	3,763
Student is Latino/Hispanic-composite	1,006
Student is Asian-composite	3,797
Student is Caucasian/White-composite	17,006

Controls. This study included measures of prior STEM advanced academic placement (AAP) achievement (X3TXAPMATCOM, X3TXAPSTATSCOM, X3TXAPBIO, X3TXAPCALCAB, X3TXAPCALCBC, X3TXAPCOMSCI, X3TXAPENVSCI, X3TXAPCHEM, X3TXAPPHYB, X3TXAPPHYELE, X3TXAPPHYMEC), as well as students' socio-economic status (X1SES), demographics (1XBLACK, 1XHISPANIC, 1XASIAN, 1XWHITE), and self-efficacy in mathematic (X1MTHEFF) or self-efficacy in science (X1SCIEFF) as a series of control predictors to account for student variation that had been shown to influence performance on standardized test scores for overall academic performance in STEM education including to assess the potential impact of self-efficacy as it relates among demographic groups. Data analysis for this section of each control of the study involved descriptive explanatory techniques including frequency tables. Frequencies and descriptive for sample characteristics are shown in Tables 3 through 6.

The frequencies for sample characteristics for self-efficacy of URMs were analyzed to compare the self-efficacy descriptive differences and similarities across the demographic group that consisted of the URM sample of African American/Black and Hispanic/Latino students. There were 2,653 African American/Black students included in the sample and 422 Hispanic students included in the sample, as these students were categorized as participants in Advanced Academic Placement (AAP) courses. As shown in Table 6, the data for the African American/Black student sample who exhibited high self-efficacy in science the mean score was -2.3654 and the standard deviation was 3.68493, while the Latino/Hispanic students in this category had a mean score of -5.2861 and a standard deviation of 3.65437. Furthermore, the data for the African American/Black student population for students who exhibited high self-efficacy in science included a mean score of -1.7131 a standard deviation of 3.467, while the Hispanic/Latino students in this category had a mean score of -5.0832 and a standard deviation of 3.80571.

Table 6

Frequencies for Sample Characteristics for Self-Efficacy of URMs

Variable	Variable Description	Frequency	Descriptive
Student Self-Efficacy in Science -African American/Black	scale of student's science self-efficacy of Student is Black or African American-composite (Predictor variables)	1=yes 0=no	N=2,653 SD=3.68493 Mean=-2.3654
Student Self-Efficacy in Science-Hispanic/Latino	scale of student's science self-efficacy of Student is Hispanic/Latino/Latina-composite (Predictor variables)	1=yes 0=no	N=422 SD=3.65437 Mean=-5.2861
Student Self-Efficacy in Mathematics- African American/Black	scale of student's mathematics self-efficacy of Student is Black or African American-composite (Predictor variables)	1=yes 0=no	N=2,653 SD=3.46700 Mean=-1.7131
Student Self-Efficacy in Mathematics- Hispanic/Latino	scale of student's mathematics self-efficacy of Student is scale of student's mathematics self-efficacy of Hispanic/Latino/Latina-composite (Predictor variables)	1=yes 0=no	N=422 SD=3.80571 Mean=-5.0832

The frequencies for sample characteristics for self-efficacy of non-URMs were analyzed to compare the self-efficacy descriptive differences and similarities across the demographic group that consisted of the non-URM sample of Asians and Caucasian/White students. However, as shown in Table 7, the data for the Asian student population for student self-efficacy in science and the Asian student population for student self-efficacy in mathematics was suppressed and missing therefore not able to be included in the analysis.

Table 7

Frequencies for Sample Characteristics for Self-Efficacy of Non-URMs

Variable	Variable Description	Frequency	Descriptive
Student Self-Efficacy in Science -Asian	scale of student's science self-efficacy of Student is Asian (Predictor variables)	Missing (data suppressed)	Missing (data suppressed)
Student Self-Efficacy in Science-Caucasian/White	scale of student's science self-efficacy of Student is White (Predictor variables)	1=yes 0=no	N=881 SD=0.0000 Mean=-8.0000
Student Self-Efficacy in Math-Asian	Student is Asian (Predictor variables)	Missing (data suppressed)	Missing (data suppressed)
Student Self-Efficacy in Math-Caucasian/White	scale of student's mathematics self-efficacy of Student is White (Predictor variables)	1=yes 0=no	N=881 SD=0.0000 Mean=-8.0000

The frequencies for sample characteristics for advanced placement courses for student self-efficacy were analyzed to compare the self-efficacy descriptive differences and similarities across the STEM advanced placement courses for all student demographics. There were 23,503 students included in the population sample (N=23,503). As shown in Table 8 on the following page, the mean score for the Student Science Self-efficacy for STEM Advanced Academic Placement (AAP) Courses Taken was -1.9670 and the standard deviation was 3.45862, while the Student mathematics Self-efficacy in this same category had a mean score of -1.5156 and a standard deviation of 3.23707.

Table 8

Frequencies for Sample Characteristics for Advanced Placement Courses for Student Self-Efficacy

Variable	Variable Description	Frequency	Descriptive
Student Science Self-efficacy for Advanced Academic Placement (AAP) Course(s) Taken *Biology, Environmental Science, Physics B, Physics C, Chemistry, and Computer science A* scores All demographics	Collective STEM AAP course performance in as it related to student SCIENCE self-efficacy for all demographics (data was suppressed in disaggregated form)	scores	N= 23,503 Mean=-1.9670 SD=3.45862
Student Mathematics Self-efficacy for Advanced Academic Placement (AAP) Course(s) Taken *Calculus AB, Calculus BC*, and *Statistics* scores All demographics	Collective STEM AAP course performance in as it related to student MATH self-efficacy for all demographics (data was suppressed in disaggregated form)	scores	N= 23,503 Mean=-1.5156 SD=3.23707

The frequencies for sample characteristics by student demographic were analyzed to compare the collective AAP course performance associated with the demographic of the student for each student demographic. The data was suppressed in disaggregated form because publicly available data were used in this study. Additionally, the demographics analyzed were grouped into URMs and non-URMs consisting of African American/Black composite and Hispanic/Latino composite for the URM group, while Asian composite and Caucasian/White composite were grouped for the non-URM group. There was a total of 23,503 students included in the population sample (N=23,503). As shown in Table 9, the African American/Black student composite sample data had a mean score of -.06 and a standard deviation of 1.451, while the Hispanic/Latino student composite data had a mean score of -.22 and a standard deviation of 1.892. The Asian student composite sample data had a mean score of 0.0 and a standard deviation of -5.00 due to missing data of which was suppressed in the dataset, while the Caucasian/White student composite data had a mean score of .51 and a standard deviation of 1.554.

Table 9

Frequencies for Sample Characteristics by Demographic

Variable	Variable Description	Frequency	Descriptive
Student is African American/Black composite	Collective AAP course performance associated with the demographic of the student (data was suppressed in disaggregated form)	scores	N= 23,503 Mean=-.06 SD=1.451
Student is Hispanic/Latino/Latina composite	Collective AAP course performance associated with the demographic of the student (data was suppressed in disaggregated form)	scores	N= 23,503 Mean=-.22 SD=1.892
Student is Asian composite	Collective AAP course performance associated with the demographic of the student (data was suppressed in disaggregated form)	scores	N= 23,503 Mean=0 SD=-5.00
Student is Caucasian/White composite	Collective AAP course performance associated with the demographic of the student (data was suppressed in disaggregated form)	scores	N= 23,503 Mean=.51 SD=1.554

Data assumptions. A valid Poisson regression Kolmogorov-Smivnov Test was conducted to verify data assumptions were met. The *p* value generated was 0.00 which indicated a result of statistical significance and did not follow a Poisson distribution (Laerd, 2015). A multivariate Poisson regression was selected as the statistical test for this study.

Hypothesis testing. The hypotheses of this causal-comparative (ex-post facto) quasi-experimental study were tested using multivariate regression analysis. There were found to be statistically significant findings among the variables tested and between URMs and non-URMs in the 12th grade analyzing scale of student's science and mathematics self-efficacy. In Table 10, it is important to note that all hypotheses findings show that all overall self-efficacy comparisons indicate that students in 9th grade and 12th grade in AAP have a higher self-efficacy in science than in mathematics, except in Table 10, as it shows that the URMs have a higher self-efficacy in mathematics self-efficacy. Future studies may need to investigate the impact of science self-efficacy on STEM academic performance on URMs, non-URMs, and low-SES. All variables meet the data assumptions for this test; however, the X1ASIAN variable had missing composite data and was not included in the non-URM analysis of the hypotheses findings as shown in table 10.

Table 10

Findings and Hypothesis Data Analysis of URMs and Non-URMs

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Non-URMs (X1WHITE)	Scale of student's science self-efficacy	2.043	1	2.043	.251	.617	.000
	Scale of student's mathematics self-efficacy	.023	1	.023	.004	.951	.000
URMs (X1BLACK + X1HISPANIC)	Scale of student's science self-efficacy	.016	1	.016	.002	.964	.000
	Scale of student's mathematics self-efficacy	11.412	1	11.412	1.820	.177	.000
X1SES	Scale of student's science self-efficacy	40698.814	1	40698.814	4995.881	.000	.175
	Scale of student's mathematics self-efficacy	43766.036	1	43766.036	6979.052	.000	.229
X3TGPASTEM	Scale of student's science self-efficacy	121.474	1	121.474	14.911	.000	.001
	Scale of student's mathematics self-efficacy	313.943	1	313.943	50.062	.000	.002
X3TGPATOT	Scale of student's science self-efficacy	52.378	1	52.378	6.429	.011	.000
	Scale of student's mathematics self-efficacy	221.373	1	221.373	35.301	.000	.002

Population and descriptive findings. The population of this study (N = 21,444) consisted of high school students in the 9th grade with a follow-on data collection at the 12th grade level for education outcomes metrics in a randomized sample within the population throughout the U.S. and the District of Columbia who attended public and private school systems during the 2009 academic school year. Participants were almost evenly split between males (51%) and females (49%) within the population data. In the sample data set, there was a slightly higher percentage of females represented than male; the female representation was at 55% and male representation was at 45%. A majority of participants in the population and thee sample were Caucasian/White (59%) and Caucasian/White (55%) respectively which is a slight decrease. The total combined URM student demographics equate to almost one-third (29%) of the population, while in the sample study the URM was only 8% of the student demographics. The URMs had a significant decrease in participation at the STEM AAP high school academic courses and continue to be underrepresented in AAP. Asian/Pacific Islander student demographics in the population are 10% but increase to 15% in the sample study of student demographics.

Instrumentation and reliability. All data used in this study was collected by the Department of Education's EDAT tool from archival datasets. The instrument used in this study was the High School Longitudinal Study of 2009 (HSLS:09) that encompasses over 23,000 pieces of data nationwide across the U.S. (NCES, 2015). A summary of the weighted student unit response rates for each round of data collection is provided in Table 11.

Table 11

Summary of HSLS:09 Response Rates with Data Collection Round and Instrumentation

HSLS:09 round	Instrument	Eligible	Responded	Weighted response rate[1]
Base year	Student questionnaire	25,206	21,444	85.7
	Student assessment	25,206	20,781	83.0
First follow-up	Student questionnaire	25,184	20,594	82.0
	Student assessment	25,184	18,507	73.0

2013 Update	Questionnaire	25,168	18,558	73.1
High school transcript	High school transcript	25,167	21,928	87.7
Second follow-up	Questionnaire	25,123	17,335	67.9

[1] All weighted percentages are calculated with the student base weight.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

The self-efficacy in AAP science and the self-efficacy in AAP mathematics were analyzed using a MANOVA to compare URMs and non-URMs to compare the similarities and differences for each student demographic, shown in Table 12. The scale of student's science self-efficacy had a mean score of -1.967 and a standard error of .022 with a lower bound 95% confidence of -2.011 and upper bound of -1.923. The scale of student's mathematics self-efficacy had a mean score of -1.516 and a standard error of .021 with a lower bound 95% confidence of -1.557 and upper bound of -1.474. The dependent variable of the student demographic is African American/Black composite had a mean score of -.056 and a standard error of .009 with a lower bound 95% confidence of -.075 and upper bound of -.038. The dependent variable of the student demographic is Hispanic/Latino composite had a mean score of -.224 and a standard error of .012 with a lower bound 95% confidence of -.248 and upper bound of -.199. The dependent variable of the student demographic is Asian composite had missing data and suppressed data. The dependent variable of the student demographic was Caucasian/White composite had a mean score of .507 and a standard error of .010 with a lower bound 95% confidence of .487 and upper bound of .527.

Table 12

Analysis of URMs (Black/African American and Hispanic/Latino) and Non-URMs (Caucasian/White and Asian) MANOVA Self-Efficacy in AAP Science and Mathematics

			95% Confidence Interval	
Dependent Variable	Mean	Std. Error	Lower Bound	Upper Bound
Scale of student's science self-efficacy	-1.967[a]	.022	-2.011	-1.923
Scale of student's mathematics self-efficacy	-1.516[a]	.021	-1.557	-1.474
Student is African American/Black composite	-.056[a]	.009	-.075	-.038

Student is Hispanic/Latino composite	-.224[a]	.012	-.248	-.199
Student is Asian composite	-5.000[a]	-.000	-5.000	-5.000
Student is Caucasian/White composite	.507[a]	.010	.487	.527

a. Covariates appearing in the model are evaluated at the following values: X3 GPA: computer/information sciences = .2602, X3 GPA: AP courses = -5.00, X3 GPA for all academic 12th grade courses = 1.4422, X3 GPA for all academic 9th grade courses = 1.7422, X3 GPA: engineering/engineering tech = -.9451, X3 Credits earned in: STEM = 6.4361, X3 GPA: science = 1.6913. Based on modified population marginal mean.

The multivariate regression model was statistically significant for the 9th grade GPA and scale of student's science and mathematics self-efficacy for the African American/Black student demographic composite with a mean squared of 1.440 and $p < .0005$ (F=.685), as shown in Table 13. Although it was not statistically significant, the 9th grade GPA and scale of student's science self-efficacy with a mean squared of 37.860 and $p < .0005$, and the mathematics self-efficacy with a mean squared of 64.956 and $p < .0005$ large differences. The student self-efficacy in mathematics were much higher than student self-efficacy in science. The model explained that the homogeneity of inter-correlation of the results were significant, suggesting that the observed covariance matrices of the dependent variables are not equal between groups in 9th grade. In other words, the correlation between 9th grade GPA, scale of student self-efficacy in mathematics and science, and demographics of URM and non-URM were not the same between groups, suggesting a significant interaction between access to the variance in resources or barriers that affect the 9th grade GPA mean scores for mathematics self-efficacy by demographic (F =6.270 in mathematics self-efficacy, F=3.206 in science self-efficacy). Overall, the aggregated self-efficacy data showed that when combining all demographics in 9th grade, most STEM AAP students tend to have a higher science self-efficacy, according to the findings in Table 13. Additionally, by demographic, there was found to be a significant decrease among student performance who are Hispanic/Latino (F=1.742) with a higher increased drop among students who are African American/Black (F=.685). These results show that the magnitude of repeated measures of mathematics test scores in 9th grade GPA self-efficacy was dependent upon the demographic variable.

Table 13

Analysis of URMs and Non-URMs STEM GPAs of AAP Courses and Self-Efficacy in Math and Science in 9th Grade of High School

Source	Dependent Variable	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
9th grade GPA X3TAGPA09	Scale of student's science self-efficacy	37.860	1	37.860	3.206	.073	.000
9th grade GPA X3TAGPA09	Scale of student's mathematics self-efficacy	64.956	1	64.956	6.270	.012	.000
9th grade GPA X3TAGPA09	Student is Hispanic/Latino composite	6.231	1	6.231	1.742	.187	.000
9th grade GPA X3TAGPA09	Student is Caucasian White composite	4.905	1	4.905	2.036	.154	.000
9th grade GPA X3TAGPA09	Student is African American/Black-composite	1.440	1	1.440	.685	.408	.000
9th grade GPA X3TAGPA09	Student is Caucasian Asian composite	.000	1	.000			

The Poisson regression model was statistically significant for the 12th grade GPA and scale of student's science self-efficacy with a mean squared of .114 and $p < .0005$, and for mathematics self-efficacy with a mean squared of .067 and $p < .0005$, as shown in Table 14. Students at this point in their level of school showed higher resulted overall in academic performance across all demographics in the dataset of AAP students. The model showed the results were significant, suggesting that the observed covariance matrices of the dependent variables are not equal between groups in 12th grade. The correlation between 12th grade GPA, scale of student self-efficacy in mathematics and science, and demographics of URM and non-URM were not the same between groups, suggesting a significant interaction between access to the variance in resources or barriers that affect the 12th grade GPA mean scores for mathematics self-efficacy by demographic ($F = .010$ in science self-efficacy, $F = .006$ in mathematics self-efficacy). Overall, the aggregated self-efficacy data showed that when combining all demographics in 12th grade, most STEM AAP students tend to have a higher science self-efficacy, according to the findings in Table 14. Additionally, by demographic, there was found to be a statistically significant finding as there was a decrease among student performance who were African American/Black (F=.998), however, there was found to be a significant increase in academic performance of Hispanic/Latino students (F=14.844). These results show that the magnitude of repeated measures of mathematics test scores in 12th grade GPA self-efficacy is dependent upon the demographic variable and the results have other external factors at the local level that may impact student GPA test scores by demographic that should be further investigated in future studies.

Table 14

Analysis of URMs and non-URMs STEM GPAs of AAP Courses and Self-Efficacy in Math and Science in 12th Grade of High School

Source	Dependent Variable	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
12th grade GPA X3TAGPA12	Scale of student's science self-efficacy	.114	1	.114	.010	.922	.000
12th grade GPA X3TAGPA12	Scale of student's mathematics self-efficacy	.067	1	.067	.006	.936	.000
12th grade GPA X3TAGPA12	Student is Hispanic/Latino/Latina composite	53.096	1	53.096	14.844	.000	.001
12th grade GPA X3TAGPA12	Student is Caucasian White composite	9.698	1	9.698	4.026	.045	.000
12th grade GPA X3TAGPA12	Student is Black/African American-composite	2.098	1	2.098	.998	.318	.000
12th grade GPA X3TAGPA12	Student is Caucasian Asian composite	.000	1	.000	---	---	---

The multivariate regression model shown in Table 15 was not statistically significant for the 12th grade mathematics courses in comparison to the scale of student science self-efficacy because the F-statistic was greater than one and the *p* value was greater than .05 for all variables of mathematics self-efficacy by demographic. However, there was a statistically significant difference across the demographic groups. The Caucasian/White student demographic group was the highest performing (F=14.914). The Latino/Hispanic demographic student group was the second highest, but there was a gap in the metrics of the scores (F=3.926). The African America/Black demographic student group were the lowest performing (F=2.350), but very close to the performance of the Hispanic/Latino group. For all student demographics, when conducting a MANOVA using 12th grade mathematics GPA and comparing the scale of the students' self-efficacy, the majority of STEM AAP students were higher in science self-efficacy (mean squared = 404.076) than mathematics self-efficacy (mean squared = 394.600). These results show that the magnitude of mathematics course score performance in 12th grade was interrelated to students' self-efficacy in math and science, and correlate with the demographic variable.

Table 15

Analysis of URMs and non-URMs STEM GPA of Math Courses and Self-Efficacy in Math and Science in 12th grade of High School

Source	Dependent Variable	Type III Sum of Squares	Df	Mean square	F	Sig	Partial Eta Squared
Mathematics X3TGPAMAT	Scale of student's science self-efficacy	4444.831	11	404.076	34.754	.000	.016
Mathematics X3TGPAMAT	Scale of student's mathematics self-efficacy	4340.601	11	394.600	38.762	.00	.018
Mathematics X3TGPAMAT	Student is Hispanic/Latino composite	154.274	11	14.025	3.926	.000	.002
Mathematics X3TGPAMAT	Student is Caucasian White composite	392.634	11	35.694	14.914	.000	.007
Mathematics X3TGPAMAT	Student is Black/ African American-composite	54.324	11	4.939	2.350	.007	.001
Mathematics X3TGPAMAT	Student is Caucasian Asian composite	.000	11	.000	---	---	---

The multivariate regression model shown in Table 16 was statistically significant for the 12th grade science courses in comparison to the scale of student science self-efficacy because the F-statistic was not greater than one and the *p* value was not greater than .05 for all variables of mathematics self-efficacy by demographic, specifically for the individual demographic variables for URMs of African American/Black student groups and Latino/Hispanic student groups. The African American/Black student group was statistically significant for the science courses taken and high self-efficacy in mathematics and science in 12th grade with a mean squared of .163 and $p < .0005$ (F=.077). The Latino/Hispanic student group was statistically significant for the science courses taken and high self-efficacy in mathematics and science in 12th grade with a mean squared of .302 and $p < .0005$ (F=.084). For all student demographics, when conducting a MANOVA using 12th grade mathematics GPA and comparing the scale of the students' self-efficacy, the majority of STEM AAP students were higher in science self-efficacy (mean squared = 447.131) than mathematics self-efficacy (mean squared = 13.815). These results show that the magnitude of science course score performance in 12th grade was interrelated to students' self-efficacy in math and science, and correlate with the demographic variable.

Table 16

Analysis of URMs and Non-URMs STEM GPA of Science Courses and Self-Efficacy in Math and Science in 12th Grade of High School

Source	Dependent Variable	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
Science X3TGPASCI	Scale of student's science self-efficacy	447.131	1	447.131	37.859	.000	.002
Science X3TGPASCI	Scale of student's mathematics self-efficacy	13.815	1	13.815	1.333	.248	.000
Science X3TGPASCI	Student is Hispanic/Latino composite	.302	1	.302	.084	.771	.000
Science X3TGPASCI	Student is Caucasian White composite	7.709	1	7.709	3.200	.074	.000
Science X3TGPASCI	Student is African American/Black-composite	.163	1	.163	.077	.781	.000
Science X3TGPASCI	Student is Caucasian Asian composite	.000	1	.000	---	---	---

The multivariate regression model shown in Table 17 was statistically significant for the 12th grade computer science courses in comparison to the scale of student mathematics and science self-efficacy because the F-statistic was not greater than one and the p value was not greater than .05 for all variables of mathematics self-efficacy by demographic, specifically for the individual demographic variables for URMs of African American/Black student groups. The African American/Black student group was statistically significant for the computer science courses taken and high self-efficacy in mathematics and science in 12th grade with a mean squared of .535 and p < .0005 (F=.254). For all student demographics, when conducting a MANOVA using 12th grade computer science AAP GPA and comparing the scale of the students' self-efficacy, the majority of STEM AAP students were higher in science self-efficacy (mean squared = 244.591) than mathematics self-efficacy (mean squared = 207.662). These results show that the magnitude of computer science course score performance in 12th grade was interrelated to students' self-efficacy in mathematics and science and correlates with the demographic variable.

Table 17

Analysis of URMs and non-URMs STEM GPA of Computer Science Courses and Self-Efficacy in Math and Science in 12th Grade of High School

Source	Dependent Variable	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
Computer Science X3TGPACOMPSCI	Scale of student's science self-efficacy	244.591	1	244.591	20.710	.000	.001
Computer Science X3TGPACOMPSCI	Scale of student's mathematics self-efficacy	207.662	1	207.662	20.044	.000	.001
Computer Science X3TGPACOMPSCI	Student is Hispanic/Latino/Latina composite	7.060	1	7.060	1.974	.160	.000
Computer Science X3TGPACOMPSCI	Student is Caucasian White composite	.215	1	.215	.089	.765	.000
Computer Science X3TGPACOMPSCI	Student is Black/ African American-composite	.535	1	.535	.254	.614	.000
Computer Science X3TGPACOMPSCI	Student is Caucasian Asian composite	.000	1	.000	---	---	---

The multivariate regression model shown in Table 18 was statistically significant for the 12th grade engineering courses in comparison to the scale of student mathematics and science self-efficacy because the F-statistic was not greater than one and the p value was not greater than .05

for all variables of mathematics self-efficacy by demographic, specifically for the individual demographic variables for URMs of Hispanic/Latino student groups. The Hispanic/Latino student group was statistically significant for the engineering courses taken and high self-efficacy in mathematics and science in 12th grade with a mean squared of 1.682 and $p < .0005$ (F=.470). For all student demographics, when conducting a MANOVA using 12th grade computer science AAP GPA and comparing the scale of the students' self-efficacy, the majority of STEM AAP students were higher in science self-efficacy (mean squared = 977.452) than mathematics self-efficacy (mean squared = 927.338). These results show that the magnitude of engineering course score performance in 12th grade was interrelated to students' self-efficacy in mathematics and science and correlates with the demographic variable.

Table 18

Analysis of URMs and Non-URMs STEM GPA of Engineering Courses and Self-Efficacy in Math and Science in 12th grade of High School

Source	Dependent Variable	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
Engineering X3TGPAENGIN	Scale of student's science self-efficacy	977.452	1	977.452	82.761	.000	.004
Engineering X3TGPAENGIN	Scale of student's mathematics self-efficacy	927.338	1	927.338	89.510	.000	.004
Engineering X3TGPAENGIN	Student is Hispanic/Latino composite	1.682	1	1.682	.470	.493	.000
Engineering X3TGPAENGIN	Student is Caucasian White composite	19.913	1	19.913	8.266	.004	.000
Engineering X3TGPAENGIN	Student is Black/ African American-composite	10.236	1	10.236	4.867	.027	.000
Engineering X3TGPAENGIN	Student is Caucasian Asian composite	.000	1	.000			

Evaluation of the Findings

The evaluation of findings section contains the interpretation of the data analysis results from the perspective of the one research question with its three sub-questions, and hypotheses including the theoretical framework was described in the study. The findings were also related to those from earlier published studies that were uncovered during the literature review. The impact and effect on the broader education field of study by this analysis is presented throughout the evaluation of findings section. The evaluation of finding closes with a summary of the most important themes of the chapter.

First and foremost, to examine the relationships between the variables, research questions were shaped to guide the study and keep the research focused. Hypotheses were designed to explore and test the research questions to determine specific parameters of which the research observations were crafted to discover. The research study model was developed and designed to address the following hypotheses of which were tested using a MANOVA analyses shown in tables 10 through 18:

$H1_0$. There is a statistically significant difference in self-efficacy and overall STEM education outcomes between URMs and non-URMs.

$H1_{a0}$. There is not a statistically significant difference in self-efficacy and mathematics AAP test scores between URMs and non-URMs.

$H1_{b0}$. There is not a statistically significant difference in self-efficacy and science AAP test scores between URMs and non-URMs.

$H1_{c0}$. There is not a statistically significant difference in self-efficacy and computer science AAP test scores between URMs and non-URMs.

The purpose of this causal-comparative (ex-post facto) quasi-experimental quantitative study was to explore whether scale of student self-efficacy in mathematics and science predicts that the independent factor of a student's socioeconomic status (SES) and demographic characteristics, when related in conjunction with the independent variable, participation in a

STEM advanced academic placement (AAP) high school course contributes positively to education outcomes. Matched comparison groups with a cross-sectional design were used test the relationships between the variables, URMs, non-URMS, self-efficacy, socioeconomic status (SES), and STEM education outcomes. The Department of Education's EDAT archival records of 8,056 high school student records were used for the 2009-2013 academic year that encompass U.S schools and aggregated data that was publicly available. Through the descriptive statistical analysis using a MANOVA, null hypotheses and alternative model of this study were tested to examine if a significant relationship existed between the predictor variables and the multiple dependent outcome variables.

The STEM academic gap among URMs and non-URMs remains well-publicized, there remains much to research on areas to investigate for effectively engaging targeted demographics in these critical occupational areas as relative and predictive intervention approaches. The results of this study were also consistent with the existing body of research that advocates for identifying ways to engage youth in STEM, specifically from lower socio-economic status (SES) and URMs, to meet the national security needs of the future as that population will become the majority of the future workforce by 2040 (Borgerding, 2015; Day, 1996; Fayer et al., 2017; Le & Robbins, 2016; Noonan, 2017). This researcher's findings supported other researcher's findings in areas around science self-efficacy. Researchers found that U.S. students' confidence in their ability to employ higher-order cognitive science skills tended to promote their confidence in their ability to accomplish practical work, strengthening their academic self-efficacy (Wang, Liang, & Tsai, 2018). Cognitive skills, practical work, and everyday application depend on a high level of science self-efficacy of which was linked to AAP student academic outcomes in the EDAT data findings of this study as an area that URMs have significantly lower than non-URMs. Few studies have investigated the relationships among these factors that compose science learning self-efficacy which is why this was an area for investigation in this study (Wang, Liang, & Tsai, 2018).

Summary

Chapter 4 began with the validity and reliability, then provided the results and evaluation of the findings along with the data description of the demographics of the participants in the study. After the instrumentation was discussed, assumptions for inferential analysis were tested. After the assumptions were verified, a MANOVA was performed to address the research question. Overall, the data were disaggregated as publicly available data and therefore the Asian demographic composite data were missing and not included in many of the non-URM data sets. The majority of the sample participant demographics were Caucasian/White and had the highest performing scores across all categories. The African American/Black and Latino/Hispanic demographic data varied in ordinal ranking placement but were of similar in data points and the non-URM category was consistently significantly higher in each area analyzed in comparison. According to the NCES (2018) study, the socioeconomic status (SES) levels of a student in the EDAT dataset support the research of which the majority of the low-SES students are also the same students with URM demographics. The results of the multilevel regressions showed support for the $H1_a$ alternative hypothesis that self-efficacy and significantly predicted a difference between URMs and non-URMs overall STEM education outcomes. Science self-efficacy seemed to be linked to success in STEM AAP academic outcomes. There was also a significant finding in the data for $H1_a$ in engineering AAP test scores for Latino/Hispanic demographic groups. Additionally, by demographic, there was found to be a statistically significant finding among student performance who were African American/Black as there was a decrease in academic performance in AAP between 9th to 12th grade test scores, however, there was found to be a significant increase in academic performance of Hispanic/Latino students with a significant increase in academic performance in AAP between 9th to 12th grade test scores. The results of the multilevel regressions showed support for the $H1_c$ alternative hypothesis that self-efficacy and significantly predicted a difference between URMs and non-URMs in science (including computer science) AAP test scores for African American/Black student demographics groups and Latino/Hispanic demographic groups. Chapter 5 will present a dialogue on the results outlined in Chapter 4 to include the inferences of these findings as related to the literature. Potential further research discovered as a result from this study will also be addressed.

Chapter 5: Implications, Recommendations, and Conclusions

The problem that was addressed in this study was there is a lower amount of youth URMs proficient in STEM who are prepared to enter STEM professions compared to Asian and Caucasian/White (non-URMs) peers, specifically minority's high school youth who are largely in low-socioeconomic (SES) groups lack student proficiency and self-efficacy in STEM advanced academic placement (AAP) courses (Cannady, Greenwald & Harris, 2014; Lian, 2017; Martinez & Guzman, 2013; Noonan, 2017; Sadler et al., 2014). The purpose of this quantitative study, utilizing a comparison research design, was to examine the difference in self-efficacy and STEM advanced academics between URMs and non-URMs with regard to the relationship between performance in high school education through the national perspective theoretical framework that drive STEM education outcomes, and identify areas to address the gap in STEM education and the STEM workforce pipeline among URMs (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). The research method was a secondary analysis using regression modeling of multiple variables from the archival data of quantified high school education data that the Department of Education collected from 2009-2013, including post-secondary school data collection in the archival Department of Education longitudinal dataset that indicated the education outcomes. There were potential limitations within the context of the problem statement, the purpose of the study, and the scope of this quantitative study primarily due to potential flaws with the use of self-reported data that may have affected the results because the state of one's mind can be impacted by one's emotional state during testing that can result in a change that cannot be distinguished within a study (Walter, 2015; Kustos and Zelkowski, 2013). Self-reported data encompasses limitations of its own within validity (Walter, 2015).

The frameworks for the next generation knowledge, skills and abilities in science, mathematics and engineering education will cover all of important STEM competencies while integrating technology as a foundational principle knowledge base. In this study, there are important STEM competencies identified to evaluate for use as relevant integrators within current frameworks that can be applied in education using the standardized job-specific database operated and maintained by the U.S. Department of Labor (Jang, 2016). Before starting this research study, an application was approved through the Institutional Review Board (IRB) and Northcentral University. There were minimal ethical concerns related with this research study as archival data were used and protected. The key ethical issue of concern was the accuracy of data collection was a key ethical issue of concern; therefore, to minimize this concern and mitigate risk, the data was acquired from a third party database, EDAT, only accessing archival data. This chapter discusses the study implications, recommendations, and concludes with suggestions for future studies.

The study was causal-comparative (ex-post facto) quasi-experimental cross-sectional, which allows for assessment of causal relationships and the observed characteristics were constructed in a comparison group using statistical techniques with demographic variables through an archival focused comparison research approach; however, because archival data were used qualitative interviews with participant were not possible to ask specific questions around the linkages of self-efficacy to STEM academic outcomes. This study was limited to URM and non-URM students participating STEM advanced academic placement (AAP) courses within the U.S. and may not be applicable to students in other countries. Limitations to the study include the sample selection within the archival data, the specific demographic groupings from which participants were drawn, and variances that occur in U.S. high schools in AAP course offerings, self-efficacy measurement scores, and educational outcome variables. All variables for URMS and non-URMs on self-efficacy and STEM AAP test scores, except for the Asian demographic, were used for the sample in this research study in the HSLS:09 EDAT dataset NCES (2018). Most of the Asian demographic consisted of suppressed data with missing values; however, it was displayed in each analysis because the use of all variables within the subgroup analyzed was an effort made to keep the dataset true to the framework and the randomized nature of the HSLS:09 longitudinal study. Also, a variable that this study did not take into account were previous STEM skills and knowledge for students, self-confidence in STEM, teaching experience of the instructors, parent's current occupation, student's expectations for occupations, parent's expectations for student in college and occupations. Further, this study did not account for the current occupation of which the AAP students who participated in the Department of Education HSLS:09 study now have at 30 years of age or older.

Implications

The results of this study contribute to the current understanding of the gap among URMs and non-URMs in STEM education as proficiency in STEM in youth education is vital to ensure their success for high school completion, college preparation, and career pathway transition to meet U.S. national security technical workforce needs of the future in fast growing occupations with rapidly changing skillset requirements (Cannady, Greenwald & Harris, 2014; Sadler, Sonnert, Hazari & Tai, 2014). With the high demand for STEM occupations and the remaining historical hiring challenge that the government, industry and academic face to fill STEM positions, the projected demographics change of the majority population in the U.S. will impact the future STEM workforce and the research in this study helps address the diversity gap issue in STEM education (U.S. Bureau of Labor Statistics, 2016; U.S. Bureau of Labor Statistics, 2017;

Fayer, Lacey, & Watson, 2017; Hall, Nishina & Lewis, 2017; Noonan, 2017; Wang & Degol, 2013). The outcomes of this research study may inform future STEM education research and STEM program development practices and policies to address long-term solutions to national security challenges regarding STEM workforce force needs, science and technology research areas, engaging and mentoring all youth in STEM, and effectively engaging URMs in education and outreach to prepare youth for next generation STEM careers and college degrees needed within STEM programs. Self-efficacy has a vital role in education, specifically self-efficacy in mathematics and self-efficacy in science as it relates to educational outcomes (Enberg & Wolniak, 2013). Additionally, the results of the multilevel regression analyses conducted in this study support the impact of self-efficacy on STEM educational outcomes and significantly predicted a difference between URMs and non-URMs overall STEM education outcomes. Student self-efficacy in high school was measured in mathematics and science, separately, using the HSLS:09 survey questions to retrieve the self-efficacy variable as a single scale number that represents a higher mathematics or science-specific self-efficacy factors of an individual based on a compilation of multiple principal components factor analyses of which the Department of Education conducted to generate the self-efficacy scale score of which additional details are provided in Appendix B (NCES, 2017).

Research question 1. The differences in self-efficacy between URMs and non-URMs that occur in student STEM education outcomes were investigated in research question one. The key finding indicated a significant difference based on self-efficacy. The first implication of the research in research question 1 was that AAP courses benefit URMs and non-URMs in critical STEM courses that provide a strong foundation for college preparedness and achievement correlated with self-efficacy in science and mathematics (Alvarado & An, 2015; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Bryan, Glynn, & Kittleson, 2011; Martinez & Guzman, 2013; Miller-Cotto, & Byrnes, 2016; Negru-Subtirica & Pop, 2016; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Sadler, Sonnert, Hazari & Tai, 2014; Stipanovic & Woo, 2017). Science self-efficacy and mathematics self-efficacy measures a student's confidence level for performance ability and includes self-belief, self-regulation, self-evaluation, self-stimulation, and self-monitoring which were elements within the pre-developed questions that were composed by the Department of Education and used for assessing mathematics and science self-efficacy in this archival data analysis study (Arlsan, 2016; Sen, 2016). The second implication was that difference in education performance assessment across demographic groups varies by self-efficacy type and socioeconomic status type (Andersen & Ward, 2014; Andrews & Stange, 2016). Lower socioeconomic status levels may limit the education opportunities available and provide inequality in secondary education for some students because of the scarcity of resources which can have a large effect on African American/Black and Hispanic/Latino students, as those students are in URM groups of which students from URMs come from the highest percentage of the U.S. low-SES population (Andersen & Ward, 2014; Andrews & Stange, 2016; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Carnevale, Cheah & Hanson, 2015; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Stephens, Hamedani, & Destin, 2014; Suziedelyte & Zhu, 2015).

Research question 1a. The differences in self-efficacy between URMs and non-URMs that occur in student mathematics AAP test scores were investigated in research question 1a. The key finding indicated a significant difference based on self-efficacy and mathematics AAP test scores. The first implication of the research in research question 1a was mathematics AAP courses provided preparation to self-efficacy and postsecondary education and career attainment (Ackerman, Kanfer & Calderwood, 2013; Astin & Oseguera, 2012; Dyce, Albold, & Long, 2013; Hwang, Choi, Lee, Culver & Hutchison, 2016; Konstantopoulos, 2006; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Sen, 2016; Shaw, Marini & Mattern, 2012; Wang, 2013; Wang & Degol, 2013). Aggregated self-efficacy data of which combined all student demographic groups were analyzed using the hypotheses and found that the comparison between students in 9th grade and 12th grade in AAP had a higher self-efficacy in science than in mathematics. However, when the findings and hypotheses data were analyzed individually for URMs and non-URMs by demographic group, the hypotheses found that all overall self-efficacy comparison between students in 9th grade and 12th grade in AAP had a higher self-efficacy in science than in mathematics, URMs had a much lower science and a higher self-efficacy in mathematics self-efficacy. Therefore, the second implication was that the science self-efficacy level may be a linked to the students' STEM educational outcomes for African American/Black and Latino/Hispanic students. The standard student questions for mathematics student self-efficacy included four inputs to scale which included self-reported responses from the students in the following areas: (a) confidence level of the 9th grader that he or she can do an excellent job on fall 2009 mathematics tests, (b) certainty level of the 9th grader that he or she can understand the fall 2009 math textbook, (c) certainty level of the 9th grader that he or she can master skills in the fall 2009 mathematics course, and (d) confidence level of the 9th grader that he or she can do an excellent job on the fall 2009 mathematics assignments (NCES, 2018).

Research question 1b. The differences in self-efficacy between URMs and non-URMs that occur in science AAP test scores were investigated in research question 1b. The key finding indicated a significant difference based on self-efficacy and science AAP test scores. The first implication of the research in question 1b was that science AAP courses provided preparation to self-efficacy and postsecondary education and career attainment (Ackerman, Kanfer & Calderwood, 2013; Astin & Oseguera, 2012; Dyce, Albold, & Long, 2013; Hwang, Choi, Lee, Culver & Hutchison, 2016; Konstantopoulos, 2006; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Sen, 2016; Shaw, Marini & Mattern, 2012; Wang, 2013; Wang & Degol, 2013). The second implication of the research in research question 1b was that science self-efficacy is linked to success in science STEM AAP academic outcomes, and all STEM AAP courses, and this study supports what other researchers have found that participation in AAP curriculum benefits students to include self-efficacy development, college planning, mentoring, and exposure to STEM-related occupations while in high school has the strength to impact persistency of diversity in STEM occupation pathways (Joy, 2006; Museus, Palmer, Davis, & Maramba, 2011). The standard student questions for science student self-efficacy included four inputs to scale which included self-reported responses from the students in the following areas: (a) confidence level of the 9th grader that he or she can do an excellent job on fall 2009 science tests, (b) certainty level of the 9th grader that he or she can understand the fall 2009 science textbook, (c) certainty level of the 9th grader that he or she can master skills in the fall 2009 science course, and (d) confidence level of the 9th grader that he or she can do an excellent job on the fall 2009 science assignments (NCES, 2018). Among the URMs students in the study sample, the African American/Black students who exhibited high self-efficacy in science were very low in comparison to their peer Latino/Hispanic students.

The third implication of research question 1b was that the effects in high school advanced science curriculum was linked to self-efficacy and had a significant positive impact on postsecondary success and outcomes (Aughinbaugh, 2012; Bottia, Stearns, Mickelson, Moller, &

Parker, 2015; Gottfried & Bozick, 2016; LeBeau et al., 2012; Legewie & DiPrete, 2014). The findings of this study support the implications through the engineering AAP test scores in correlation to the scale of student mathematics and science self-efficacy scores for Latino/Hispanic demographic groups were significantly low (p = .470). Additionally, the African American/Black demographic groups in this study were low in engineering (p = 4.867) which has long-term implications on the higher-education and career trajectories of which minority students choose to select as viable future options. The results of the multilevel regressions showed support for self-efficacy and significantly predicted a difference between URMs and non-URMs in science (including STEM engineering) AAP test scores for URMs. The AAP high school engineering courses is also an area of which STEM targeted initiatives may need to focus to increase URM STEM education outcomes due to the implications.

Research question 1c. The differences in self-efficacy between URMs and non-URMs that occur in computer science AAP test scores were investigated in research question 1c. The key finding indicated a significant difference based on self-efficacy and AAP computer science test scores. The first implication of the research in research question 1c was that out-of-school STEM programs can be an important turning point for implementing comprehensive and lasting improvements in STEM education through hands-on activities, low-pressure/ungraded activities, multi-age groupings, flexible uses of time) to inspire, sustain, and deepen the youth's interest in STEM fields and develop an understanding and commitment to scientific, technology, engineering, and mathematical communities and in the areas of computer science many out-of-school programs have been created (Falk & Dierking, 2010; Overton, 2015; Shankar & Kalil, 2013; Traphagen & Traill, 2014). In this study, in correlation to the scale of student mathematics and science self-efficacy scores for computer science AAP test scores, the academic performance for African American/Black students were slightly higher than Caucasian/Whites. The results may imply that there is a connection with the launch of the computer science-STEM (CS-STEM) government-funded initiatives promoting out-of-school student activities, mentoring and teacher training in computer science. Education disparities have been examined have been found across many demographic groups in STEM education with many challenges regarding access to resources and student influencers view of the value of education, however, in computer science minority students in AAP high school were found to have better performance than their peers in this study (Atwater, Johnson, Lance & Woodard, 2013; Newton & Sandoval, 2015). The second implication was that as students' progress through their time in the high school, their self-efficacy and student STEM education outcomes should increase; however, this was not the case for URMs. Longitudinal data was found to be insightful for connecting multiple pieces of data together over a duration of time while drawing on historical research. While analyzing the data points of the 9th grade time frame and 12th grade time frame of the student sample, an additional correlation was identified of which was the academic performance of a student over time in STEM as an educational outcome. A decrease in academic performance was found among African American/Black student performance in AAP between 9th to 12th grade test scores, while there was a significant increase in academic performance of Hispanic/Latino students between 9th to 12th grade test scores. Non-URMs student performance in AAP between 9th to 12th grade test scores increased.

The third implication for research question 1c was that AAP computer science courses is an area of which STEM initiatives may need to focus to increase URM STEM education outcomes (Atwater, Johnson, Lance & Woodard, 2013; Balfanz, 2009; Bedolla, 2012; Burt, Ortlieb & Cheel, 2013; Flanagan & Levine, 2010; Garrett, Barr & Rothman, 2009; Hester &

Pellowski, 2014; Matto, Spera & Wentzel, 2008; Mayes & Moore, 2016; Newton & Sandoval, 2015; West-Olatunji, Saunders, Mehta & Behar-Harenstein, 2010; U.S. Bureau of Labor Statistics, 2017; Walker & Pearsall, 2012). The African American/Black student group was statistically significant for the computer science courses taken and high self-efficacy in mathematics and science in 12th grade. However, the scale of student mathematics and science self-efficacy scores for computer science AAP test scores for Latino/Hispanic students were significantly higher. The results of the multilevel regressions showed support for self-efficacy and significantly predicted a difference between URMs and non-URMs in science (including computer science) AAP test scores URMs.

Additionally, the overall aggregated student performance in AAP between 9th to 12th grade test scores was correlated with self-efficacy in mathematics and self-efficacy in science was conducted. The overall aggregate score for 9th grade showed that students participating in the study had a much higher self-efficacy in mathematics than science, nearly double in score. The overall aggregate score for 12th grade remained the same. The inference here was that the decrease in academic performance of African American/Black students in high school AAP needs to be further investigated as universities have seen a similar decline as URM students enter STEM undergraduate programs and GPAs tend to decline ultimately leading to a change out of a STEM discipline or dropping out of college. Moreover, the results of the study supported majority of the low-SES students were also found to be linked to the same student population as those with URM demographics (NCES, 2018). Low-SES is overrepresented by minority population, specifically from African American/Black and Latino/Hispanic populations (Gates et al., 2017; Kastberg et al., 2016; Lauen, & Gaddis, 2013).

Recommendations

The following recommendations, both in terms of practical application (practice) and future research (theory) were constructed from the results of the current study. The findings of the research questions offer practical application with regard to STEM education and outreach program assessment and implementation, in addition to suggestions for further research studies for shaping policy and in STEM and for URM and non-URM education and outreach initiatives that pipeline the next generation national security defense workforce in government, industry and academia (Andersen & Ward, 2014; Andrews & Stange, 2016; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Carnevale, Cheah & Hanson, 2015; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Stephens, Hamedani, & Destin, 2014; Suziedelyte & Zhu, 2015). Clearly, the findings of the questions suggest the need for further exploration in addressing the problem (Alvarado & An, 2015; Bohrnstedt, Kitmitto, Ogut, Sherman, & Chan, 2015; Bryan, Glynn, & Kittleson, 2011; Martinez & Guzman, 2013; Miller-Cotto, & Byrnes, 2016; Negru-Subtirica & Pop, 2016; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Palardy, Rumberger & Butler, 2015; Sadler, Sonnert, Hazari & Tai, 2014; Stipanovic & Woo, 2017). Additional studies are recommended in theory specifically with longitudinal designs and practice with deeper measures of targeted methods of science self-efficacy and STEM education outcomes for URMs that take into account designs with multi-sites, experimental, and quasi-experimental longitudinal studies that test the influence of various education and outreach program characteristics using structural equation modeling (Ackerman, Kanfer & Calderwood, 2013; Astin & Oseguera, 2012; Dyce, Albold, & Long, 2013; Hwang, Choi, Lee, Culver &

Hutchison, 2016; Konstantopoulos, 2006; Olszewski-Kubilius, Steenbergen-Hu, Rosen & Thomson, 2017; Sen, 2016; Shaw, Marini & Mattern, 2012; Wang, 2013; Wang & Degol, 2013).

Recommendations for Practice.

A recommendation for practice was that since this was an archival study that the results can be applied to practical application with regard to STEM education and outreach program assessment and initiative implementation. Student self-efficacy in mathematics and especially in science, have an impact on advanced academic achievement of URMs and non-URMs and should be considered as areas for assessment and student development when building STEM education and outreach initiatives, especially for URMs as science self-efficacy could be affecting their success in the STEM program and in the education classroom. Science self-efficacy is linked to STEM education outcomes and is identified as a gap with URMs in this research study findings. Additionally, in-and out-of-school STEM initiatives with long-term sustainable resourcing are critical for URM success to address the low-SES paradox of which research shows that the minority population, specifically from African American/Black and Latino/Hispanic populations (Gates et al., 2017; Kastberg et al., 2016; Lauen, & Gaddis, 2013).

Recommendations for Theory.

The findings of research question and sub-questions indicate the need for future research. First, a mixed-methodology analysis of the existing Federal STEM Education initiatives should be conducted using the framework and building on the results of this study to further understand the findings and potential external environmental factors that may impact students STEM education outcomes in these areas (Howard-Brown and Martinez; 2012; Klugman, 2012; MacPhee, Farro & Canetto, 2013). Also, it is recommended that parental influencer and teacher attributes, such as teacher self-efficacy, be included and measured (Newton & Sandoval, 2015;

Riccitui 2010; Roderick, 2003; Rollins & Valdez, 2006). A second recommendation for future research was to perform a smaller study on a specific classroom or STEM initiative using this same design as a longitudinal study to investigate the progression of developmental students in a particular program while customizing the survey and touching base with the respondents more frequently than the EDAT dataset allowed in addition to student participation in specific Federal or Defense STEM Initiatives or internships, Industry STEM initiatives or internships, or University internships to gauge the direct influence and compare the investment values to youth education (Aughinbaugh, 2012; Bottia, Stearns, Mickelson, Moller, & Parker, 2015; Gottfried & Bozick, 2016; LeBeau et al., 2012; Legewie & DiPrete, 2014). Undoubtedly, this type of study would be time-consuming, expensive, and difficult but is possible with strong partnerships across government, academia and industry; furthermore, this type of research may provide practical solutions to the return on investment that organizations are seeking while addressing the national security STEM workforce problem presented in this study. Furthermore, incorporating multiple respondents while providing the same questions about the student could allow for a stronger test instrument with better validity and reliability than self-reporting. Furthermore, URMs characteristics and challenges need to be considered when shaping STEM Initiatives and future studies should be shaped to measure the challenges by demographic group that were addressed in the literature review using a mixed-method study to determine the changes that can be made in general STEM education classes to mitigate the barriers and also provide pathways into increase self-efficacy to ultimately enter STEM AAP courses (Aughinbaugh, 2012; Bottia, Giersch, Engberg & Wolniak, 2013; Mickelson, Stearns, & Moller, 2015; Moller et al., 2015; Rohr, 2012; Zelkowski, 2011). These studies are recommended as there is the need to shape academic research, education policy, federal and Defense policy in STEM, STEM workforce recruitment and acquisition, and for URM and non-URM education and outreach initiative development that pipeline the next generation national security defense workforce in government, industry and academia using these findings in the classroom, in STEM education program, and in future research (Gottron, 2017; Tehan, 2017).

Recommendations for Future Research

Recommendations for future research included a qualitative analysis of the study to interview the URM and non-URM subjects to better understand the self-efficacy in math and science as it related to their current occupations as an adult in addition to the past educational challenges faced during the period of time the data collection occurred. Another recommendation would be to perform a quantitative study to investigate the impact of the parental influencers and teachers for the student population investigated during this study. Finally, a mixed-method study examining those learners who were participating in general education STEM courses at low-SES composite schools and high-SES composite schools to compare the differences between education outcomes for AAP course access at school as it relates to self-efficacy and the rationale for student success in mathematics and science as it relates to general education STEM courses and education resources. Future research of recommendations for theory and subsequent recommendations for implementing may be applied through studies using mixed methodologies with longitudinal data collection approaches that examine the quantitative data surrounding the circumstance and allowing for questions of the subjects involved to gauge the impact of the STEM education programs and external environmental factors of which the students experience at the local level.

Researchers have referenced the widespread national security issue facing the U.S. in STEM education with the nation's minority youth and the diversity gaps that will lack the

STEM education knowledge foundation required to successfully transition into young adulthood without a strong STEM education in secondary school, which will require remediate education and training to overcome the gap between non-URM colleagues to attain STEM degrees and STEM occupations (Carnevale et al., 2015; Houston & Yonghong, 2016; Latterell & Wilson, 2013). Across all of the STEM occupational groups examined by the Bureau of Labor Statistics (BLS), employment is expected to grow by 16.9 percent over the period 2010-2020, which is slightly higher than the overall U.S. growth rate (National Academies Press, 2012). Moreover, there are more than 2.8 million STEM job openings expected to open by 2020 based on the projected BLS labor force estimates (National Academies Press, 2012). Both industry and government face a technical workforce shortage with an unbalanced demographic population pipeline in STEM fields that are quantified and monitored through communities of interests, federal interagency working groups, and ongoing workforce analyses projections; however, the results of this study and future research can provide insight into practices that are associated with STEM education policies and successful student-focused STEM initiative assessment and intervention outcomes consistent with focus areas that provide evidence with links to improved performance in STEM education outcomes, while providing pertinent scientific contributions and advancing the existing body of knowledge (Kastberg et al., 2016; Noonan, 2017).

The current research study utilized a correlational study design using archival data of which was limited by the sample selection within the archival data. Future research and the subsequent practice associations may be implemented through individualized STEM education program studies, in addition to longitudinal studies exploratory why the STEM education gap remains in specific STEM discipline areas as it relates to self-efficacy and external environment factors that are unique to the program or classroom of the student participates in, including the interaction with the sponsoring organization with the student. Recommendations for future research included a qualitative analysis of the study to interview the subjects to better understand the challenges faces during the period of time the data collection occurred. Another recommendation would be to perform a quantitative study to investigate the impact of the parental influencers and teachers for this student population. Finally, a mixed-method study examining those learners who were is general education STEM courses at low-SES composite schools and without AAP courses to determine reasons for their success and linkages to self-efficacy in mathematics and science as it relates to general education STEM courses and education outcomes.

There is an emergent need for research, policy, and practice for addressing the need for U.S. STEM competency of which youth have the ability to understand and apply concepts from STEM classroom education and connect those to solve the next challenge in their learning pathway that leads to a real-world related problem. The results of this study utilized a theoretical framework grounded in student self-efficacy and STEM Education outcomes and based on Self-Determination Theory (SDT) and Social Cognitive Career Theory (SCCT) to provide the framework for support of student interest in STEM education and careers through fostering strong self-efficacy in STEM advanced academic courses (Deci & Ryan, 1985; Halim, Abd Rahman, Zamri, & Mohtar, 2017; Hall et al., 2017; Latterell & Wilson, 2013; Lent, Brown, and Hackett, 1994; Papadimitriou, 2014; Salkind, 2010). The core components of SCCT include an interaction of personal attributes (e.g., self-efficacy and race), external environmental factors (e.g., educational opportunities and socioeconomic status) and overt behaviors (e.g., course selection and past experience) of which all lead to career-related outcomes. For the SCCT core components, the current study focused on self-efficacy, socioeconomic status, course selection in

AAP, and past experience in AAP. Moreover, career choice behavior and career field interest are largely impacted by career self-efficacy which are deeply embedded in academic course instructions and STEM outreach engagement (Lent & Brown, 1996).

Lent et al., (1994) indicated that career-related self-efficacy can be increased through effective experiences focused on career-related tasks which begins with early intervention in youth academia. Therefore, a pathway for students to map their educational continuum through the workforce was developed and encompasses measures beyond the traditional STEM initiative assessment, focusing on the individual and how government, industry and academia can better engage youth in high school to avoid the critical juncture attrition rates, while educating and attracting more youth in a targeted manner to STEM education and occupations of becoming a scientist, engineer or mathematician. Researcher, policy makers and STEM educators can use this theoretical framework and the research findings as a benchmark tool for AAP high school STEM education outcomes and self-efficacy for minorities to guide future studies.

Conclusions

The objective of this quantitative, causal-comparative (ex-post facto) quasi-experimental study was to examine the difference in self-efficacy and STEM education outcomes between URMs and non-URMs (Kettler & Hurst, 2017; Olszewski-Kubilius et al., 2017; Redmond-Sanogo et al., 2016; Sen, 2016). The theoretical foundation for this research study was Self-Determination Theory (SDT) and Social Cognitive Career Theory (SCCT) to provide the framework for support of student interest in STEM education and careers through fostering strong self-efficacy in STEM advanced academic courses and bound core components of the current study on self-efficacy, socioeconomic status, course selection in AAP, and past experience in AAP (Deci & Ryan, 1985; Lent, Brown, and Hackett, 1994; Salkind, 2010). As applied to this study, Self-Determination Theory (SDT) predicts the independent variables, URM and non-URM demographics and self-efficacy were used to influence or explain the dependent variable, STEM AAP course.

Government, industry and academia face a significant challenge in attracting capable and talented technical minds to address U.S. national security mission needs. Youth in the U.S. education system need sustainably funded STEM education and outreach programs to pipeline them into clear pathways that address the URM demographic needs and low-socioeconomic needs. The current federal STEM initiatives should be re-examined to determine any adjustments needed and federal diversity strategy alignment and integration, emphasizing educational impact and sustainability. Federal policies in support of sustainable long-term programs that meet URM and low-SES targeted goals should be established and aligned directly to the needs and goals of the federal government. Moreover, URMs and low-SES data are connected showing the majority of the low-SES population including African American/Black and Latino/Hispanic demographic groups; moreover, students who attend a low-SES composite school (Gates et al., 2017; Kastberg et al., 2016; Lauen, & Gaddis, 2013). Moreover, research shows that students who attend a low-SES composite school were less likely to have access to the advanced mathematics and science curriculum that provides intense coursework and had long-term negative educational impacts on a student's postsecondary academic achievement outcomes (Kelly & Sheppard, 2009; Museus, Palmer, Davis, & Maramba, 2011).

The government, industry and academia should work together to share research to solve this impending national security STEM issue, create and adjust STEM initiatives to resolve this issue, and continue to collaborate as allies in the STEM education, research and outreach area to develop, recruit, and retain STEM youth who become STEM professionals of who will create new inventions, capabilities and entire portfolios that can change with way the U.S. conducts business, educates, and defends the nation. Through the statistical results of multivariate regressions, the multiple findings can lead to a viable pipeline of talent leading to a more diverse STEM workforce and increased diversity of thought for working together on complex in a future environment.

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Appendices

Appendix A: STEM Fields and STEM-Related Fields Defined by NSF

Fields in STEM and fields related to STEM were defined using the National Science Foundation's Science and Engineering Indicators (NCES, 2012).

Table A1

Mathematics, Computer Science and Technology Fields in STEM and STEM-Related Fields as Defined by the National Science Foundation

NSF STEM Fields (with NCES major educational categories)
Computer and mathematical sciences
• Computer and information sciences
• Computer/information sciences
• Computer science
• Computer systems analysis
• Information services and systems
• OTHER computer and information sciences
• Computer and Info Sci. Minor group
Mathematics and statistics
• Applied mathematics
• Mathematics, general
• Operations research
• Statistics
• OTHER mathematics
• Mathematical Sciences Minor group
• Computer and Math Minor group
NSF STEM-related Fields (with NCES major educational categories)
Science and Mathematics Teacher Education
• Computer teacher education
• Mathematics teacher education
Technology and Technical Fields
• Computer programming
• Data processing
• Electrical and electronic technologies
• Industrial production technologies
• Mechanical engineering-related technologies
• OTHER engineering-related technologies

Table A2

Science Fields in STEM and STEM-related Fields as Defined by the National Science Foundation

NSF STEM Fields (with NCES major educational categories)	
Biological, agricultural and environmental life sciences	
Agricultural and food sciences • Animal sciences • Food sciences and technology • Plant sciences • OTHER agricultural sciences • Agricultural and Food Minor group	Environmental life sciences • Environmental science or studies • Forestry sciences Environmental Sciences Minor group
Biological sciences • Biochemistry and biophysics • Biology, general • Botany • Cell and molecular biology • Ecology • Genetics, animal and plant • Microbiological sciences and immunology • Nutritional sciences	• Pharmacology, human and animal • Biological Sciences Minor group • Physiology and pathology, human and animal • Zoology, general • OTHER biological sciences • Life and Related Sciences Major group
Physical and related sciences	
Chemistry, except biochemistry • Chemistry, except biochemistry	
Earth, atmospheric and ocean sciences • Atmospheric sciences and meteorology • Earth sciences • Geology	• Geological sciences, other • Oceanography • Earth Sciences Group Minor
Physics and astronomy • Astronomy and astrophysics • Physics • Physics and Astronomy Minor Group	
Other physical sciences	
• OTHER physical sciences • Science, unclassified	
Physical and related sciences major group • Physical and Related Science Major Group	
NSF STEM-related Fields (with NCES major educational categories)	
Health	
• Audiology and speech pathology • Health services administration • Health/medical assistants • Health/medical technologies • Medical preparatory programs (e.g. pre-dentistry,-medical,-veterinary) • Medicine (dentistry, optometry, osteopathic, podiatry, veterinary)	• Nursing (4 years or longer program) • Pharmacy • Physical therapy and other rehabilitation/therapeutic services • Public health (including environmental health and epidemiology) • OTHER health/medical sciences
Science and Mathematics Teacher Education	
• Science teacher education • Social science teacher education	
Other Science and Engineering related fields	
• Architecture/Environmental Design • Actuarial science	

Appendix B: HSLS:09 Research Study Data Analytics and Technical Notes

Appendix B provides information about the High School Longitudinal Study of 2009 (HSLS:09), as well as information about the statistical procedures and analysis variables used in this study. The HSLS:09 base student questionnaire was 26 pages and consisted of nearly 100 questions. The Department of Education’s federal Office of Management and Budget (OMB) number for the survey was 1850-0852. The federal government requires that each federal agency that collects data obtain an OMB number to and comply with federal data collection requirements; therefore, the High School Longitudinal Study of 2009 adhered to these federal requirements for the base study and all follow-up studies. The questions presented to the students in the study of which were in-turn used as data for this study are presented in Tables A3 through A8 which provide an overview of the questionnaires separated by section for collecting student data.

Table A3

HSLS:09 Student Questionnaire Organized by Section (Section A: Student Background)

HSLS:09 Student Questionnaire Organized by Section	
SECTION A: Student Background	
What is your sex? ☐ Male ☐ Female	Are you Hispanic or [Latino/Latina]? ☐ Yes ☐ No
Which of the following are you? ☐ Mexican, Mexican-American, Chicano ☐ Cuban ☐ Dominican ☐ Puerto Rican	☐ Central American such as Guatemalan, Salvadoran, Nicaraguan, Costa Rican, Panamanian, or ☐ Honduran ☐ South American such as Colombian, Argentine, or Peruvian ☐ Other Hispanic or Latino or Latina
[In addition to learning about your Hispanic background, we would also like to know about your racial background.] Which of the following choices describe your race? You may choose more than one. (Check all that apply.) ☐ White ☐ Black or African American	☐ Asian ☐ Native Hawaiian or other Pacific Islander American Indian or Alaska Native
Which one of the following are you? ☐ Chinese ☐ Filipino	☐ Southeast Asian such as Vietnamese or Thai ☐ South Asian such as Indian or Sri Lankan ☐ Other Asian such as Korean or Japanese
What is your birth date? – Month – Day ☐ Year ☐ 1991 or earlier	☐ 1992 ☐ 1993 ☐ 1994 ☐ 1995 ☐ 1996 or late
What was the first language you learned to speak when you were a child? Was it... ☐ English ☐ Spanish	☐ Another language ☐ English and Spanish equally or ☐ English and another language equally?
What is the [other] language you first learned to speak? ☐ A European language, such as French, German, or Russian ☐ A Chinese language ☐ A Filipino language	☐ A Southeast Asian language such as Vietnamese or Thai ☐ A South Asian language such as Hindi or Tamil ☐ Another Asian language such as Japanese or Korean ☐ A Middle Eastern language such as Arabic or Farsi, or ☐ Another language
How often do you speak [this language] with your mother or female guardian at home? ☐ Never ☐ Sometimes ☐ About half the time	☐ Most of the time ☐ Always ☐ No mother or female guardian in your household
How often do you speak [this language] with your friends? ☐ Never ☐ Sometimes	☐ About half the time ☐ Most of the time ☐ Always

Table A4

HSLS:09 Student Questionnaire Organized by Section (Section B: Previous School Experiences)

Questions with Options Organized by Student Questionnaire Section	
SECTION B: Previous School Experiences	
What grade were you in last school year (2008-2009)? ☐ 7th Grade ☐ 8th Grade ☐ 9th Grade ☐ You were in an ungraded program	
During the last school year (2008-2009), did you attend [current school] or did you attend a different school? [current school] ☐ Different school ☐ You were homeschooled	
During the last school year (2008-2009), what school did you attend? – School Name – City – State/Foreign County	
Since the beginning of the last school year (2008-2009), which of the following activities have you participated in? (Check all that apply.) ☐ Math club ☐ Math competition ☐ Math camp ☐ Math study groups or a program where you were tutored in math	☐ Science club ☐ Science competition ☐ Science camp ☐ Science study groups or a program where you were tutored in science ☐ None of these
Since the beginning of the last school year (2008-2009), how often have you done the following science activities? ☐ Read science books and magazines ☐ Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Accessed web sites for computer technology information ☐ Never	☐ Rarely ☐ Sometimes ☐ Often ☐ Visited a science museum, planetarium or environmental center ☐ Never ☐ Rarely ☐ Sometimes ☐ Often
What math course did you take in the 8th grade? If you took more than one math course, please choose your most advanced or most difficult course. ☐ Math 8 ☐ Advanced or Honors Math 8 not including Algebra ☐ Pre-algebra ☐ Algebra I including IA and IB	☐ Algebra II or Trigonometry ☐ Geometry ☐ Integrated Math ☐ Other advanced math course such as pre-calculus or calculus ☐ Other math
What was your final grade in this math course? (If your school uses numerical grades only, please answer in terms of the letter equivalent. If you don't know the equivalent, assume that ... ☐ 90 to 100 is an "A" ☐ 80 to 89 is a "B" ☐ 70 to 79 is a "C" ☐ 60 to 69 is a "D" ☐ Anything less than 60 is "below D")	☐ A ☐ B ☐ C ☐ D ☐ Below D ☐ Your class was not graded
What science course did you take in the 8th grade? If you took more than one science course, please choose your most advanced or most difficult course. ☐ Science 8 ☐ General Science or General Science 8 ☐ Biology ☐ Life science ☐ Pre-AP or pre-IB Biology ☐ Chemistry	☐ Earth Science ☐ Environmental Science ☐ Integrated Science ☐ Principles of Technology ☐ Physical Science ☐ Physics ☐ Other science course
What was your final grade in this science course? (If your school uses numerical grades only, please answer in terms of the letter equivalent. If you don't know the equivalent, assume that ... ☐ 90 to 100 is an "A" ☐ 80 to 89 is a "B" ☐ 70 to 79 is a "C" ☐ 60 to 69 is a "D" ☐ Anything less than 60 is "below D")	☐ A ☐ B ☐ C ☐ D ☐ Below D ☐ Your class was not graded

Table A5

HSLS:09 Student Questionnaire Organized by Section (Section C: Math Experiences)

Questions with Options Organized by Student Questionnaire Section	
SECTION C: Math Experiences	
How much do you agree or disagree with the following statements? ☐ You see yourself as a math person ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree	☐ Others see you as a math person ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
When you are working on a math assignment, how often do you think you really understand the assignment? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often	
Are you currently taking a math course this fall? [Were you taking a math course in the fall of 2009?] ☐ Yes ☐ No	
What math course(s) are you currently taking this fall? [What math course(s) were you taking in the fall (2009)?] (Check all that apply.) ☐ Algebra I including IA and IB ☐ Geometry ☐ Algebra II ☐ Trigonometry ☐ Review or Remedial Math including Basic, Business, Consumer, Functional or General math	☐ Integrated Math I ☐ Statistics or Probability ☐ Integrated Math II or above ☐ Pre-algebra ☐ Analytic Geometry ☐ Other advanced math course such as pre-calculus or calculus ☐ Other math course
Why are you taking [fall 2009 math course]? [If late December or later add: If you are no longer taking this course, think back to the fall when you answer this question and the questions that follow.] (Check all that apply.) ☐ You really enjoy math ☐ You like to be challenged ☐ You had no choice, it is a school requirement ☐ The school counselor suggested you take it ☐ Your parent(s) encouraged you to take it	☐ A teacher encouraged you to take it ☐ There were no other math courses offered ☐ You will need it to get into college ☐ You will need it to succeed in college ☐ You will need it for your career ☐ It was assigned to you ☐ Some other reason ☐ You don't know why you are taking this course
How much do you agree or disagree with the following statements about your [fall 2009 math course]? ☐ You are enjoying this class very much ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You think this class is a waste of your time ☐ Strongly agree	☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You think this class is boring ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
How much do you agree or disagree with the following statements about the usefulness of your [fall 2009 math] course? What students learn in this course... ☐ is useful for everyday life. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ will be useful for college. ☐ Strongly agree	☐ Agree ☐ Disagree ☐ Strongly disagree ☐ will be useful for a future career. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
How much do you agree or disagree with the following statements about your [fall 2009 math] course? ☐ You are confident that you can do an excellent job on tests in this course ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You are certain that you can understand the most difficult material presented in the textbook used ☐ in this course ☐ Strongly agree ☐ Agree ☐ Disagree	☐ Strongly disagree ☐ You are certain that you can master the skills being taught in this course ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You are confident that you can do an excellent job on assignments in this course ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
How much do you agree or disagree with the following statements about [your math teacher]? Remember, none of your teachers or your principal will see any of the answers you provide. Your math teacher... ☐ values and listens to students' ideas. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ treats students with respect. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ treats every student fairly. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ thinks every student can be successful. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ thinks mistakes are okay as long as all students learn. ☐ Strongly agree	☐ Agree ☐ Disagree ☐ Strongly disagree ☐ treats some kids better than other kids. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ makes math interesting. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ treats males and females differently. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ makes math easy to understand. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

Table A6

HSLS:09 Student Questionnaire Organized by Section (Section D: Science Experiences)

Questions with Options Organized by Student Questionnaire Section		
SECTION D: Science Experiences		
How much do you agree or disagree with the following statements? You see yourself as a science person ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree		☐ Others see you as a science person ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
When you are working on a science assignment, how often do you think you really understand the assignment? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often		
Are you currently taking a science course this fall? [Were you taking a science course in the fall of 2009?] ☐ Yes ☐ No		
What science course(s) are you currently taking this fall? [What science course(s) were you taking in the fall (2009)?] (Check all that apply.) ☐ Biology I ☐ Earth Science ☐ Physical Science ☐ Environmental Science ☐ Physics I ☐ Integrated Science I ☐ Chemistry I ☐ Integrated Science II or above		☐ Anatomy or Physiology ☐ Advanced Biology such as Biology II, AP, or IB ☐ Advanced Chemistry such as Chemistry II, AP, or IB ☐ General Science ☐ Principles of Technology ☐ Life Science ☐ Advanced Physics such as Physics II, AP or IB ☐ Other earth or environmental sciences such as ecology, geology, oceanography, or meteorology ☐ Other biological sciences such as botany, marine biology, or zoology ☐ Other physical sciences such as astronomy or electronics ☐ Other science course
Why are you taking [fall 2009 science course]? [If late December or later add: If you are no longer taking this course, think back to the fall when you answer this question and the questions that follow.] (Check all that apply.) ☐ You really enjoy science ☐ You like to be challenged ☐ You had no choice, it is a school requirement ☐ The school counselor suggested you take it ☐ Your parent(s) encouraged you to take it		☐ A teacher encouraged you to take it ☐ There were no other science courses offered ☐ You will need it to get into college ☐ You will need it to succeed in college ☐ You will need it for your career ☐ It was assigned to you ☐ Some other reason ☐ You don't know why you are taking this course
How much do you agree or disagree with the following statements about your [fall 2009 science] course? You are enjoying this class very much ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You think this class is a waste of your time ☐ Strongly agree		☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You think this class is boring ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
How much do you agree or disagree with the following statements about the usefulness of your [fall 2009 science] course? What students learn in this course... ☐ is useful for everyday life. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ will be useful for college. ☐ Strongly agree		☐ Agree ☐ Disagree ☐ Strongly disagree ☐ will be useful for a future career. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
How much do you agree or disagree with the following statements about your [fall 2009 science] course? You are confident that you can do an excellent job on tests in this course ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You are certain you can understand the most difficult material presented in the textbook used in this ☐ course ☐ Strongly agree ☐ Agree ☐ Disagree		☐ Strongly disagree ☐ You are certain you can master the skills being taught in this course ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ You are confident that you can do an excellent job on assignments in this course ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
How much do you agree or disagree with the following statements about [your science teacher]? Remember, none of your teachers or your principal will see any of the answers you provide. Your science teacher... ☐ values and listens to students' ideas. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree		☐ treats students with respect. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
treats every student fairly. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ thinks every student can be successful. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ thinks mistakes are okay as long as all students learn. ☐ Strongly agree	☐ Agree ☐ Disagree ☐ Strongly disagree ☐ treats some kids better than other kids. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ makes science interesting. ☐ Strongly agree ☐ Agree ☐ Disagree	☐ Strongly disagree ☐ treats males and females differently. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ makes science easy to understand. ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

Table A7

HSLS:09 Student Questionnaire Organized by Section (Section E: Home and School)

<table>
<tr><th colspan="4">Questions with Options Organized by Student Questionnaire Section</th></tr>
<tr><th colspan="4">SECTION E: Home and School</th></tr>
<tr><td colspan="2">How much do you agree or disagree with the following statements about your current school?
You feel safe at this school
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
You feel proud being part of this school
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
☐</td><td colspan="2">There are always teachers or other adults in your school that you can talk to if you have a problem
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
School is often a waste of time
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
Getting good grades in school is important to you
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree</td></tr>
<tr><td colspan="2">How often do you...
go to class without your homework done?
☐ Never
☐ Rarely
☐ Sometimes
☐ Often
go to class without pencil or paper?
☐ Never
☐ Rarely
☐ Sometimes
☐ Often</td><td colspan="2">go to class without books?
☐ Never
☐ Rarely
☐ Sometimes
☐ Often
go to class late?
☐ Never
☐ Rarely
☐ Sometimes
☐ Often</td></tr>
<tr><td colspan="2">Not including lunch or study periods, what is your favorite school subject?
☐ English
☐ Foreign Language
☐ Science
☐ Art
☐ Music
☐ Mathematics</td><td colspan="2">☐ Physical Education or Gym
☐ Religion
☐ Health Education
☐ Computer Education or Computer Science
☐ Social Studies, History, Government, or Civics
☐ Career preparation class such as health professions, business, or culinary arts
☐ Other</td></tr>
<tr><td colspan="2">Not including lunch or study periods, what is your least favorite school subject?
☐ English
☐ Foreign Language
☐ Science
☐ Art
☐ Music
☐ Mathematics</td><td colspan="2">☐ Physical Education or Gym
☐ Religion
☐ Health Education
☐ Computer Education or Computer Science
☐ Social Studies, History, Government, or Civics
☐ Career preparation class such as health professions, business, or culinary arts
☐ Other</td></tr>
<tr><td colspan="2">How much do you agree or disagree with the following statements?
Studying in school rarely pays off later with good jobs
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
Even if you study, you will not be able to get into college
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree</td><td colspan="2">Even if you study, your family cannot afford to pay for you to attend college
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
Working is more important for you than attending college
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree</td></tr>
<tr><td colspan="2">Since the beginning of the last school year (2008-2009), which of the following people have you talked with about which math courses to take this year?
(Check all that apply.)
☐ Your mother or female guardian
☐ Your father or male guardian</td><td colspan="2">☐ Your friends
☐ A favorite teacher
☐ A school counselor
☐ None of these people</td></tr>
<tr><td colspan="2">Since the beginning of the last school year (2008-2009), which of the following people have you talked with about which science courses to take this year?
(Check all that apply.)
☐ Your mother or female guardian
☐ Your father or male guardian</td><td colspan="2">☐ Your friends
☐ A favorite teacher
☐ A school counselor
☐ None of these people</td></tr>
<tr><td colspan="2">Since the beginning of the last school year (2008-2009), which of the following people have you talked with about which courses to take this year other than math and science courses?
(Check all that apply.)
☐ Your mother or female guardian
☐ Your father or male guardian</td><td colspan="2">☐ Your friends
☐ A favorite teacher
☐ A school counselor
☐ None of these people</td></tr>
<tr><td colspan="2">Since the beginning of the last school year (2008-2009), which of the following people have you talked with about going to college?
(Check all that apply.)
☐ Your mother or female guardian
☐ Your father or male guardian</td><td colspan="2">☐ Your friends
☐ A favorite teacher
☐ A school counselor
☐ None of these people</td></tr>
<tr><td colspan="2">Since the beginning of the last school year (2008-2009), which of the following people have you talked with about possible jobs or careers when you are an adult?
(Check all that apply.)
☐ Your mother or female guardian
☐ Your father or male guardian</td><td colspan="2">☐ Your friends
☐ A favorite teacher
☐ A school counselor
☐ None of these people</td></tr>
<tr><td colspan="2">Since the beginning of the last school year (2008-2009), which of the following people have you talked with about personal problems?
(Check all that apply.)
☐ Your mother or female guardian
☐ Your father or male guardian</td><td colspan="2">☐ Your friends
☐ A favorite teacher
☐ A school counselor
☐ None of these people</td></tr>
<tr><td colspan="2">As far as you know, are the following statements true or false for your closest friend? Your closest friend...
gets good grades.
☐ True
☐ False
is interested in school.
☐ True
☐ False</td><td colspan="2">attends classes regularly.
☐ True
☐ False
plans to go to college.
☐ True
☐ False</td></tr>
<tr><td colspan="2">How much do you agree or disagree with each of the following statements?
If you spend a lot of time and effort in your math and science classes...
you won't have enough time for hanging out with your friends.
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
you won't have enough time for extracurricular activities.
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree</td><td colspan="2">you won't be popular.
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
people will make fun of you.
☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree</td></tr>
<tr><td colspan="2">In general, how would you compare males and females in each of the following subjects?
English or language arts
☐ Females are much better
☐ Females are somewhat better
☐ Females and males are the same
☐ Males are somewhat better
☐ Males are much better</td><td colspan="2">Math
☐ Females are much better
☐ Females are somewhat better
☐ Females and males are the same
☐ Males are somewhat better
☐ Males are much better
Science
☐ Females are much better
☐ Females are somewhat better
☐ Females and males are the same
☐ Males are somewhat better
☐ Males are much better</td></tr>
<tr><td>During a typical weekday during the school year how many hours do you spend...
working on math homework and studying for math class?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours
working on science homework and studying for science class?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours
working on homework and studying for the rest of your classes?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours</td><td>participating in extracurricular activities such as sports teams, clubs, band, student government?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours
working for pay not including chores or jobs you do around your house?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours</td><td>spending time with your family?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours
hanging out or socializing with your friends?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours
☐ 5 or more hours</td><td>watching television or movies?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
playing video games?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours
chatting or surfing online?
☐ Less than 1 hour
☐ 1 to 2 hours
☐ 2 to 3 hours
☐ 3 to 4 hours
☐ 4 to 5 hours
☐ 5 or more hours</td></tr>
<tr><td colspan="2">Are you participating in any of the following programs?
Talent Search
☐ Yes
☐ No
Upward Bound
☐ Yes
☐ No</td><td colspan="2">Gear Up
☐ Yes
☐ No
No AVID (Advancement in Individual Determination)
☐ Yes
☐ No
MESA (Mathematics, Engineering, Science Achievement)
☐ Yes
☐ No</td></tr>
</table>

Table A8

HSLS:09 Student Questionnaire Organized by Section (Section F: Plans for Postsecondary Education)

Questions with Options Organized by Student Questionnaire Section
SECTION F: Plans for Postsecondary Education
Including this year, how many years of math do you expect to take during high school? ☐ One year ☐ Two years ☐ Three years ☐ Four or more years
What are the reasons you plan to take more math courses during high school? (Check all that apply.) ☐ Taking more math courses is required to graduate ☐ Your parents will want you to ☐ Your teachers will want you to ☐ Your school counselor will want you to ☐ You are good at math ☐ You will need more math courses for the type of career you want ☐ Most students who are like you take a lot of math courses ☐ You enjoy studying math ☐ Taking more math courses will be useful for getting into college ☐ Taking more math courses will be useful in college ☐ Your friends are going to take more math courses ☐ Some other reason ☐ You don’t know why, you just probably will
Do you plan to enroll in... an Advanced Placement (AP) calculus course? ☐ Yes ☐ No ☐ You haven't decided yet ☐ You don't know what this is an International Baccalaureate (IB) calculus course? ☐ Yes ☐ No ☐ You haven't decided yet ☐ You don't know what this is
Including this year, how many years of science do you expect to take during high school? ☐ One year ☐ Two years ☐ Three years ☐ Four or more years
What are the reasons you plan to take more science courses during high school? (Check all that apply.) ☐ Taking more science courses is required to graduate ☐ Your parents will want you to ☐ Your teachers will want you to ☐ Your school counselor will want you to ☐ You are good at science ☐ You will need more science courses for the type of career you want ☐ Most students who are like you take a lot of science courses ☐ You enjoy studying science ☐ Taking more science courses will be useful for getting into college ☐ Taking more science courses will be useful in college ☐ Your friends are going to take more science courses ☐ Some other reason ☐ You don’t know why, you just probably will
Do you plan to enroll in... an Advanced Placement (AP) science course? ☐ Yes ☐ No ☐ You haven't decided yet ☐ You don't know what this is an International Baccalaureate (IB) science course? ☐ Yes ☐ No ☐ You haven't decided yet ☐ You don't know what this is
An "education plan" or a "career plan" is a series of activities and courses that you will need to complete in order to get into college or be successful in your future career. Have you put together... ☐ a combined education and career plan ☐ an education plan only ☐ a career plan only or ☐ none of these?
Who helped you put your [education and career/education/career] plan together? (Check all that apply.) ☐ A counselor ☐ A teacher ☐ Your parents ☐ Someone else ☐ No one
Have you taken or are you planning to take... the PSAT? ☐ No ☐ Yes ☐ You haven't decided yet You don't know what this is the SAT? ☐ No ☐ Yes ☐ You haven't decided yet ☐ You don't know what this is American College Testing Service (ACT) test? ☐ No ☐ Yes ☐ You haven't decided yet ☐ You don't know what this is an Advanced Placement (AP) test? ☐ No ☐ Yes ☐ You haven't decided yet ☐ You don't know what this is ☐ a test for the International Baccalaureate (IB)? ☐ No ☐ Yes ☐ You haven't decided yet ☐ You don't know what this is
How sure are you that you will graduate from high school? ☐ Very sure you'll graduate ☐ You’ll probably graduate ☐ You probably won’t graduate ☐ Very sure you won’t graduate

Table A8

HSLS:09 Student Questionnaire Organized by Section (Section G: Life After High School)

Questions with Options Organized by Student Questionnaire Section
SECTION G: Life After High School
As things stand now, how far in school do you think you will get? ☐ Less than high school ☐ High school diploma or GED ☐ Start but not complete an Associate's degree ☐ Complete an Associate's degree ☐ Start but not complete a Bachelor's degree ☐ Complete a Bachelor's degree ☐ Start but not complete a Master's degree ☐ Complete a Master's degree ☐ Start but not complete a Ph.D., M.D., law degree, or other high level professional degree ☐ Complete a Ph.D., M.D., law degree, or other high level professional degree ☐ Don't know
How sure are you that you will go on to college to pursue a Bachelor's degree after you leave high school? ☐ Very sure you'll go ☐ You'll probably go ☐ You probably won't go ☐ Very sure you won't go
Whatever your plans, do you think you have the ability to complete a Bachelor's degree? ☐ Definitely ☐ Probably ☐ Probably not ☐ Definitely not
Would you be disappointed if you did not graduate from college with a Bachelor's degree by the time you are 30 years old? ☐ Yes ☐ No
What do you plan to do during your first year after high school? (check all that apply.) ☐ Enroll in an Associate's degree program in a two-year community college or technical institute ☐ Enroll in a Bachelor's degree program in a college or university ☐ Obtain a license or certificate in a career field ☐ Attend a registered apprenticeship program ☐ Join the armed services ☐ Get a job ☐ Start a family ☐ Travel ☐ Do volunteer or missionary work ☐ Not sure what you want to do
Are you more likely to attend a public or private 4-year college, or have you not thought about this yet? ☐ Public ☐ Private ☐ Haven't thought about this
Are you more likely to attend an in-state or out of state 4-year college, or have you not thought about it yet? ☐ In-state ☐ Out of state ☐ Haven't thought about this
Have you gotten information about the cost of tuition and mandatory fees at a specific [in-state public/out-of-state public/private] college? ☐ Yes ☐ No
What is the cost of one year's tuition and mandatory fees at that public 4-year college in your state? Include the cost of courses and required fees such as student activity fees and student health fees. Do not include optional expenses such as room and board.
Is that tuition and mandatory fees only, or does that also include other fees such as room and board? ☐ Tuition and mandatory fees only ☐ Tuition, mandatory fees, and other fees
What is the cost of one year's tuition and mandatory fees at that private 4-year college? Include the cost of courses and required fees such as student activity fees and student health fees. Do not include optional expenses such as room and board.
What is your best estimate of the cost of one year's tuition and mandatory fees at a public 4-year college in your state?
How confident are you in the accuracy of your estimate of the cost of one year's tuition and mandatory fees at a public 4-year college in your state? Are you... ☐ very confident ☐ somewhat confident or ☐ not at all confident?
As things stand now, what is the job or occupation that you expect or plan to have at age 30? ☐ You don't know ☐ No ☐ Yes
How much have you thought about this choice? Have you thought about it... ☐ not at all ☐ a little ☐ somewhat or ☐ a lot?
When you talk about your plans for the future, would you say you talk... ☐ mostly to your parents ☐ more to your parents than your friends ☐ to your parents and your friends about the same ☐ more to your friends than your parents ☐ mostly to your friends or ☐ you don't talk to your parents or to your friends about your plans for the future?

The data were analyzed using the questionnaire responses in the archival data collected by Department of Education pulled from a data collection storage called EDAT. The summary of the responses rates for the data collection and instrumentation can be found in Table A9 which provides a break-out of the eligible respondents and weighted response rates.

Table A9

Summary of HSLS:09 Response Rates with Data Collection Round and Instrumentation

HSLS:09 round	Instrument	Eligible	Responded	Weighted response rate[1]
Base year	Student questionnaire	25,206	21,444	85.7
	Student assessment	25,206	20,781	83.0
	Parent questionnaire[2]	25,206	16,995	67.5
	School administrator[2]	25,206	23,800	94.5
	School counselor[2]	25,206	22,790	90.0
	Teacher questionnaires			
	Math teacher[2]	23,621	17,882	71.9
	Science teacher[2]	22,597	16,269	70.2
First follow-up	Student questionnaire	25,184	20,594	82.0
	Student assessment	25,184	18,507	73.0
	Parent questionnaire[3]	11,952	8,651	72.5
2013 Update	Questionnaire	25,168	18,558	73.1
High school transcript	High school transcript	25,167	21,928	87.7
Second follow-up	Questionnaire	25,123	17,335	67.9

[1] All weighted percentages are calculated with the student base weight.
[2]Note that, in High School Longitudinal Study of 2009 (HSLS:09) 2013 Update and High School Transcript Study: A First Look at Fall 2009 Ninth-Graders in 2013, weighted response rates were calculated using the analytic weight, rather than the student base weight, for these five instruments. Therefore, for these five instruments, the counts of eligible and responding sample members and weighted response rates differ between those reported in the 2013 Update First Look report and those reported here, which were calculated using the student base weight.
[3]A subsample of parents was selected to receive the parent survey in the first follow-up. Further details on the parent subsample design are provided in section 3.3.4 of the High School Longitudinal Study of 2009 (HSLS:09) Base Year to First Follow-Up Data File Documentation.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Appendix C: Student Self-Efficacy Measurements in Mathematics and Science

Student self-efficacy in high school was measured by each mathematics and science, separately, using the HSLS:09 survey questions to retrieve the self-efficacy variable as a single scale number that represents a higher mathematics or science-specific self-efficacy factors of an individual based on a compilation of multiple principal components factor analyses of which the Department of Education conducted to generate the self-efficacy scale score.

Scale of Student's Mathematics Self-Efficacy

This variable is a composite scale of the student's math self-efficacy of which higher values represented higher math self-efficacy and were labeled as X1MTHEFF in the Department of Education EDAT dataset. The Department of Education created this composite variable through a principal components factor analysis using a weighted student distribution (W1STUDENT) and standardized to a mean of 0 and standard deviation of 1. There were four inputs to this scales which included self-reported responses from the students in the following areas: (a) confidence level of the 9th grader that he or she can do an excellent job on fall 2009 mathematics tests (S1MTESTS), (b) certainty level of the 9th grader that he or she can understand the fall 2009 math textbook (S1MTEXTBOOK), (c) certainty level of the 9th grader that he or she can master skills in the fall 2009 mathematics course (S1MSKILLS), and (d) confidence level of the 9th grader that he or she can do an excellent job on the fall 2009 mathematics assignments (S1MASSEXCL). Only respondents who provided a full set of responses were assigned a scale value. If the student indicated that he or she was not taking a fall mathematics class, the Department of Education set this variable to -7. The coefficient of reliability (alpha) for the scale was .65 (NCES, 2017). Additional information on the self-efficacy scale score in mathematics can be found in chapter 5 of the Base-Year Data File Documentation of NCES 2011-328 (NCES, 2017).

Scale of Student's Science Self-Efficacy

This variable is a composite scale of the student's science self-efficacy of which higher values represented higher science self-efficacy and were labeled as X1SCIEFF in the Department of Education EDAT dataset. The Department of Education created this composite variable through a principal components factor analysis using a weighted student distribution (W1STUDENT) and standardized to a mean of 0 and standard deviation of 1. There were four inputs to this scales which included self-reported responses from the students in the following areas: (a) confidence level of the 9th grader that he or she can do an excellent job on fall 2009 science tests (S1STESTS), (b) certainty level of the 9th grader that he or she can understand the fall 2009 science textbook (S1STEXTBOOK), (c) certainty level of the 9th grader that he or she can master skills in the fall 2009 science course (S1SSKILLS), and (d) confidence level of the 9th grader that he or she can do an excellent job on the fall 2009 science assignments (S1SASSEXCL). Only respondents who provided a full set of responses were assigned a scale value. If the student indicated that he or she was not taking a fall science class, the Department of Education set this variable to -7. The coefficient of reliability (alpha) for the scale was .65 (NCES, 2017). Additional information on the self-efficacy scale score in science can be found in chapter 5 of the Base-Year Data File Documentation of NCES 2011-328 (NCES, 2017).

Appendix D: List of Potential STEM Partners for Government across Academia and Industry

A website search was conducted using the list of federal agencies that invested in STEM initiatives and organizations that partnered through committees, activities, or other investments of STEM programs in a way that aligned with federal, academia and industry common goals. The query resulted in over 1,000 potential partners for collaboration across federal, academia and industry in various areas of STEM ranging from formal to informal education with numerous target audiences such as educators, students, researchers, and volunteers at all levels of the education continuum. In industry and academia partners, there were found to be 823 active STEM players. In academia, there were found to be 292 higher education institutions with STEM fields and initiatives. Table A10 provides a list of potential STEM partners for government across academia and industry; however, this is not a mutually exclusive collectively exhaustive list.

Table A10

Potential List of STEM Partners for Government across Academia and Industry

Name of Organization with STEM Education and Outreach Investments
STEM Education Coalition
National Science Teachers Association (NSTA)
Hands on Science Partnership
EDC Learning Transforms Lives
National Council of Teachers of Mathematics (NCTM)
Microsoft
ACS Chemistry for Life
ASME Setting the Standard
ARSA
Afterschool Alliance
American Association of Colles for Teacher Education (AACTE) Serving Learners
American Farm Bureau Foundation for Agriculture
American Society for Biochemistry and Molecular Biology
American Society for Civil Engineers (ASCE)
ASA
Association of Public and Land Grant Universities
Battelle The Business of Innovation
ETS
eic
ExxonMobil
FIRST
Measured Progress
National Association of Manufactures
National Consortium of Secondary STEM Schools (NCSSS)
National Instruments
North American Association for Environmental Education (naaee)

National Society for Black Engineers (NSBE)
Project Lead The Way (PLTW)
SHPE
Society of Women Engineers (SWE)
Texas Instruments
Universal Technical Institute
FESTO
21st Century Academy
3E Institute/West Chester University
A.P.N.G. Enterprises, Inc.
AAP/PreK-12 Learning Group
Abercrombie Academy
Academy of Greatness & Excellence
Academy of Science- St. Louis
Academy of Teacher Excellence, University of Texas at San Antonio
AccuRounds
Achieve3000
Acoustical Society of America
ACT
Addictive Science
Adobe Systems, Inc.
AeA
Aerospace Industries Association
Aerotek Scientific LLC
African American Mutual Assistance Network, Inc. -(AAMAN)
Agbo: The Geek Training Boutique
Air Force Association
Air Force Association - Keystone Chapter
Air-Conditioning, Heating, and Refrigeration Institute
Allegheny-Singer Research Institution
Alliance to Save Energy
Altshuller Institute for TRIZ Studies, Inc.
America's Foundation for Chess
American Association for the Advancement of Science
American Association of Museums
American Association of Physicists in Medicine
American Association of Physics Teachers
American Association of University Women
American Astronomical Society
American Council of Engineering Companies
American Council on Education
American Dental Education Association
American Educational Research Association
American Federation of Teachers
American Fisheries Society
American Geophysical Union
American Geosciences Institute
American Home Healthcare Services, Inc.

American Indian Science and Engineering Society
American Institute of Aeronautics and Astronautics
American Institute of Biological Sciences
American Institute of Pharmaceutical Technology
American Institute of Physics
American Interactive Marketing (AiM)
American Mathematical Society, DC Office
American Mathematical Society, Headquarters
American Meteorological Society
American Modeling Teachers Association
American Museum of Natural History
American Nuclear Society
American Physical Society
American Physiological Society
American Society for Engineering Education (ASEE)
American Society for Microbiology
American Society of Agronomy
American Society of Heating, Refrigerating and Air Conditioning Engineers
American Sociological Association
Amputee Long Drive Competition
AMS Academic Solutions
Anand Niketan
Angel Overseas
Ann Thomas Center
AOPA Foundation
AQLEM: American Quality Leadership and Educational Management
Aquaponics USA/STEM Food Growing Systems
ARC Capital Development
Arctic Research Consortium of the United States
Ardnek-Jacovitz, LLC
Arizon Companies
Arizona Association of Teachers of Mathematics (AATM)
Arizona Geological Survey
Arizona Science Teachers Association (ASTA)
Arizona Technology in Education Association (AzTEA)
Arlington Public Schools
Art of Problem Solving Academy
Arts & Scraps
ASHRAE Puerto Rico Chapter
ASINED
Asociatia STIM (STEM Education)
Aspire Mentoring Excel (AME)
Assiut STEM School
Association for Women in Science
Association of Public and Land-Grant Universities
Association of Science-Technology Centers
Association of State Supervisors of Mathematics
Association of Women in Forensic Science, Inc.

Astra Women's Business Alliance S.T.E.A.M. Program
Athena Career Academy
Athena Learning Centers
Aviation Institute of Maintenance
Bahcesehir University (STEM Center)
Baltimore County Public Schools
Baltimore Washington Corridor Chamber Foundation
Baltimore/Washington Corridor Chamber of Commerce
Bay Area Council
Bayer Corporation
Beanstalk Consulting Group
Bentley Systems, Inc
Berkeley STEM Academy
Big Red Bell
Big South Fork P-16 Council
Biocom
Biological Sciences Curriculum Study (BSCS)
Biophysical Society
BirdSleuth K-12, Cornell Lab of Ornithology
Black Nurses Rock – Baltimore Chapter
BluPrint Learning
Boise State University
Boone Middle School
Boston University
Botanical Research Institute of Texas
BoxZor
Boys & Girls Club of Massena
BrainKids Creative Workshop
Branch Out
Broward College STEM Center
Business Higher Education Forum
Butler Community College
Bytes For Bits
Cairo American College
Caldwell Associates Architects
Caleb University Lagos
California Aerospace Academy
California Healthcare Institute
California State University
California State University, Sacramento
California STEM Learning Network
Camp Invention
Capistrano Valley Christian Schools
Careers in Science, Technology, Engineering and Mathematics (CSTEM) Program
Carel Associates Inc.
Carnegie Science Center
Carolina Biological Supply Company
Carrot

Carter G. Woodson School
Cascade School District
Cell Signaling Technology, Inc.
Center for Advanced Studies in Science, Math, and Technology at Wheeler High School
Center for American Progress
Center for Education in STEM at UNCW
Center for Educational Outreach, Whiting School of Engineering, Johns Hopkins University
Center for Elementary Mathematics and Science Education (CEMSE), The University of Chicago
Center for Excellence in Education (CEE)
Center for Mathematics, Science, and Technology Education, UNC Charlotte
Center for Minority Achievement in Science and Technology (CMAST)
Central Arizona College
Centura College
CFY
Chabot Space & Science Center
Chalcedony Educational Research Consult
Challenger Center
Change is Simple, Inc.
Chaparral High School
Charlotte Mecklenburg Schools
Charlottesville Business Innovation Council (CBIC)
Chesapeake Bay Foundation
Chicago Public Schools
Children's Workshop for the Recording Arts
Christopher Columbus Middle School
Chromatography Essentials
Circle Cross Ranch K-8 STEM Academy
City of Williamsport, MA
Civil & Environmental Engineering Dept., Idaho state University
Civil Air Patrol
Clark Construction Group, LLC
Closing The Digital Gap
CMR GROUP LLC
Coalition for Science After School
Coastal Synapse
CODeLLA.org
Coder Dojo NOVA
Coggins International
College of New Jersey
Collier County Public Schools
Commonwealth Covenant Fund
Commonwealth Information Technology Initiative
Communities Foundation of Texas
Community Business Incubator
Community Services Foundation
CompTIA
Computer Science Online
Computer Science Teacher Association

Computing Research Association
Concord Consortium - East Coast
Concord Consortium - West Coast
Connection, Inc. - Public Sector
Connolly Middle School
Consortium for Ocean Leadership
Consortium of Social Science Associations
Cook & Cook Inc DBA Royal Welding & Fabricating
Council of Graduate Schools
Council on Undergraduate Research
Covenant Christian Schools
Crop Science Society of America
CSTEM
CT Academy for Education in Mathematics, Science, & Technology, Inc.
Cubic Simulation System
Curriculum for Agricultural Science Education
Case 4 Learning
DC Public Schools
Deep Foundations Institute Educational Trust
DeHavilland Associates
Del Mar College
Delaware Valley Friends School
Delta Education
Department of Homeland Security
Design Science
Destination Imagination, Inc.
Dev League, LLC
Dick's Classic Garage Auto Museum and Event Center
Digital Media Academy
Discovery Education
Discovery Logic
Discovery Place, Inc.
Divinekinship Inc
Docere4Parents
Dolphin STEM Academy
DOW STEMtheGAP
Downtown Doral Charter Elementary School
Drive Incorporated
DuPage High School, Illinois
Duro UAS
Durr Enterprise Corporation
Dycet Research Group
E2 Young Engineers – Buffalo
Eagles Nest Youth Association
Earth Networks
EAST Initiative
Eastern Washington University
E-Blox, Inc.

Ecological Society of America
EdTechLens
EduCare Foundation
Education and Sports Performance Academy
Education Soaring Inc.
Educational Advancement Foundation
EduPerts Consultancy
Einstein Project
Eklavya Innovision
Electroninks/Circuit Scribe
Elemco Software Integration Group Ltd.
Elementary Science Coalition
Elements of the Community, Inc.
Elevation Education
Embry-Riddle Aeronautical University, Aviation Maintenance Science Department
Emerge the Conference, LLC
Emerson
energiLAB
Engineering Career Launcher
Engineering is Elementary
Engineers Without Borders—USA
Entrancezone
Eridu Education United
Ethnos Research Incorporated
EUMETSAT
Eureka Toy and Gift LLC
Euskedi Ikertze
EVERFI Inc
Everyday Intellect Inc.
Exploratorium
Fairfax County Public School System
Faithworks Inc.
Falmouth High School
FancyLab
Federation of Galaxy Explorers
FemNet, LLC
Festo Didactic, Incorporated
Fidgets2Widgets, LLC
Flinn Scientific, Inc
Florida Industrial and Phosphate Research Institute
Florida Polytechnic University
Fort Bend Education Center and After School Programs
Fort-Bend Technical & Medical Vocational Careers & Knowledge First Inc
Fremont STEM
French & Parrello Associates
Friends of Lac Lawrann Conservancy
Frog Publications
Frogtown Connection

FurQaan Academy
Future City Competition
Generación CODE
Generation Infocus
Geological Society of America
George Mason University
German American Aviation Heritage Foundation
Girl Scouts of the USA
Girls Inc.
Global Leadership Institute
Global Trade & Technology
GOA Learningtree
Granville Central School District – Technology Education
Graytech Software, Inc.
Greater Cleveland Neighborhood Center Association
Greater Life of Fayetteville, INC (GLOF)
Greater Phoenix Chamber of Commerce
Green Valley Middle School
Growing Scholars Educational Center
Gyanam Technologies Inc.
Hackground
Hammond Park Flyers Club
Happy Learning Center
Harman's ATA Martial Arts
Harris Search Associates
Healthcare Leadership Council
Healthy Habitats
Helping Others Foundation
High School Options
Hise Scientific Instrumentation, LLC
Hise Scientific Instrumentation, LLC
Hochberg Preparatory School
Hope College Center for Exploratory Learning
Horse Power
HoshizakiIceMaker.com
Hot Trending Toys
Howard County Public School
Hydrouino Robotics
iExploreSTEM
iFem Wireless, Inc.
I-ImpactSTEM
Illinois State Board of Education
Indiana STEM Resource Network
Indiana University
Indiana University Southeast
Indoff Inc.
Indoor Farms for Education (a subsidiary of Indoor Farms of America)
Indoor Farms for Education, Inc.

InfoWest
Inman Middle School Technology Foundation
Innodust Techsolution
Innovation New Jersey
Innovative Semiconductor Solutions LLC
INNOVIM, LLC
Inquiry Science Education Consortium
Institute for Creative Technologies
Institute for Global Environmental Strategies (IGES)
Institute of Electrical & Electronics Engineers-USA
Institute of Food Technologists
Instituto SantaFe
International Innovation
International Society for Technology in Education
International Technology and Engineering Educators Association
Inventionland Institute
InvetiRobot!
Iridescent
Israel Sci-Tech Schools Network
It Takes a Village Africa
ITT Educational Services, Inc.
Ittner Architects
iUrban Teen
JASON Learning
JES & Co.
JL Cambridge International Inc.
Johns Hopkins University
Joint Non-Lethal Weapons Directorate (JNLWD)
Judson ISD
Junior Engineering Technical Society (JETS)
KaBOOM!
KampKits.com
Kayenta Middle School STEM Association
Kenan Fellows Program for Curriculum and Leadership Development
Kendall Hunt Publishing Company
Kent State University, Department of Computer Science
Kentucky Department of Education
Keystone Science School
KI
Kids Drone Zone
Kids First Awareness 21st Century Community Learning Center
KinderCare Education
Kinetic Body Mechanics
Kitables
Knodemy Inc.
Knowledge Alliance
Kutztown University of Pennsylvania
Lampire Biological Laboratories

Laver and Downes
Lawrence Hall of Science, UC Berkeley
Learn How To Become
Learning Bits (dba Science Bits)
Learning for Future Education Technology Company Ltd.
LearnOnLine, Inc
Level Up Village
Lewis Burke Associates
Liberal Arts 2 Business
Lincoln Memorial University School of Business
Lisaiceland
Little Angels International School
Little Einsteins East Africa
Lockheed Martin Corporation
Long & Associates
Long Island LEADS
Los Angeles Memorial Coliseum
Louisiana Tech University's SciTEC in the College of Education
Lower Merion School District, PA
Lyotropic Therapeutics, Inc.
Magnet Schools of America
Maine Mathematics and Science Alliance
Malach Education Consulting Group
Maplewood Career Center
Marine Technology Society
Mary of Nazareth Catholic School
Maryland Science Center
Mast STEM Academy
Math for America
Mathematical Association of America
Mayville State University
McCoy & McCoy Laboratories
MedEdPath
MedtoMarket Consulting, Inc
Methodist University Computer Science Department
Miami-Dade County Public Schools
MindGym School
Minds and Minds Play and Skills Center
Minnesota Center for Engineering and Manufacturing
Missouri Department of Elementary and Secondary Education
MIT
MIT Alumni Association
MRL Wealth Strategies
Mt. Olive High School FIRST Robotics Teams 11 & 193
Museum of Science, Boston
Music Triage LLC
MVCAAPR – Museo Virtual Puerto Rico
MVHS Municipal Centre of Further Education

Nace International
National 4-H Youth Conference Center
National Academies
National Academy of Engineering
National Academy of Science
National Action Council for Minorities in Engineering
National Alliance for Partnerships in Equity
National Alliance of State Science and Mathematics Coalitions
National Association for Alternative Certification
National Association of Biology Teachers
National Center for Educational Accountability Just For the Kids
National Center for Simulation
National Center for STEM Elementary Education
National Center for Technological Literacy
National Center for Women & Information Technology
National Child Development Council
National Commission on Teaching and America's Future
National Council for Advanced Manufacturing
National Council for Community and Education Partnerships
National Council of Structural Engineers Associations
National Defense Education Program
National Defense Industrial Association
National Education Association
National Energy Foundation
National Energy Technology
National Financial Educators Council
National GEM Consortium
National Girls Collaborative Project
National Inventors Hall of Fame
National Maritime Heritage Foundation
National Robotics League
National Science Education Leadership Association
National Science Foundation
National Security Space Office (NSSO)
National Society for Professional Engineers
National Society of Black Engineers
National Society of Professional Engineers
National Tooling & Machining Association
National Trail High School
National Venture Capital Association
Naturalists at Large
Naval Surface Warfare Center
Nazarbayev Intellectual School of Physics and Mathematics in Taraz
NEO, Inc.
Neptune Township School District
Nevada School of Professional Studies
Nevada Virtual Academy
New Classrooms Innovation Partners

New England Council
New Ideas and Innovation Trust
New Market Skills Center
New Mexico State University
New York Hall of Science
New York Sunworks
Newton's Road
Next Steps Institute: Earth Force
No Stones Magazine
North Carolina School for the Deaf
North Central Technical College
North Dakota STEM Network
Northeastern University
Northern Kentucky University
Northridge Middle School (Charlotte-Mecklenburg Schools)
Northside High School Advanced Applied STEM Career Academy
Nova Enrichment Academy
NuVu
NYCPromise
NYS Technology and Engineering Educators Association
O'Mara HR
O'Neill, Athy & Casey Law and Government Relations
Oak Knoll School of the Holy Child
Oak Ridge Associated Universities
Ocean County College
Oconomowoc Area School District, WI
Office of the State Superintendent of Education, Washington DC
Ohio Academy of Science
Ohio Department of Education
Ohio Mathematics and Science Coalition
Ohio Resource Center for Mathematics, Science, and Reading
Ohio State University
Omaha Marching Phoenix Drill Team
Oldcastle Inc.
Olive Children Foundation
One-to-One Institute
ORDINEM
Orlando Science Center
OurBluebirdTrails.org
Outdoor Promise
Outlier Research & Evaluation, CEMSE | University of Chicago
Owen Software Development Company
PA Space Grant Consortium
Pacific Northwest Division of Family Practice
Pathways into Science
PCS Edventures
Pearson Education Publishing
Penn State Center for Science and the Schools

Pennsylvania Drug Discovery Institute
Petiole Games
Pharmaceutical Research and Manufacturers of America
Pitsco Education
Pittsburgh Institute of Aeronautics (PIA)
Pittsburgh Institute of Aeronautics (PIA): Hagerstown Campus
Pittsburgh Institute of Aeronautics (PIA): Myrtle Beach Campus
Pittsburgh Institute of Aeronautics (PIA): Youngstown-Warren Campus
Plan of Action for Challenging Times Inc
PlantingScience
Play Centers, Inc.
Pleasant Valley High School, Chico CA
Plum Borough School District
Precious Learning Center
Prince George's County Public Schools
Pro Speaker
Project Exploration
Project Lead the Way
Project Made Foundation
Project STEAM Tv
Promote STEM
Public Agenda
Public Broadcasting Service
Purdue University
Quatro Solutions
Queen Associates, Inc.
Queens University of Charlotte
Quinde Foundation
Radnor Partners4STEM
Raising Supaman Project
Readiness Learning Associates
Rebuild Workforce Project, LLC
Redbird Flight Simulators
Region 12 Schools
Rent-A-Theme Entertainment
RF Globalnet
Riverside Health of Maryland
RMJM Hillier
Robert Turner College and Career High School
ROBOSTANGS
Rolling Hills Prep and Renaissance Schools
Rosie Riveters
Ross Kelman Associates
Royal Palm Consulting
Rutgers University
S.A.Y. Yes (CRU Youth Development)
SACNAS-SHPE-MAES Consortium
Sacred Heart Catholic School

Saddleback Valley Educational Foundation
SAE International
SAE, Inc.
Saint Francis University
Samaritan Health Services
San Joaquin Valley College
Saving our Sons & Sisters
SC Coalition for Mathematics & Science
SC Research Authority (SCRA)
Scheer Intelligence
School Science and Mathematics Association
Science Academy of Chicago
Science Companion
Science Explorers Inc.
Science for Youth / BFOIT
Science, Technology, Engineering and Mathematics (STEM) for Childhood Education at Hunter College
Sci-Port Discovery Center
Scitel Academy
SE3D Education
Seattle Lutheran High School
Securetech 360 LLC
Sedona 30
Serious Games Association
Seyet LLC
Shenandoah Elementary School
Shiloh High School
Skillpoint Alliance
Skybot Challenge
SMART Competition
Smith System
Society for Research in Child Development
Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)
Society of Automotive Engineers
Society of Hispanic Professional Engineers Foundation
Society of Manufacturing Engineers
Society of Women Engineers
Software and Information Industry Association
Soil Science Society of America
Solar One
Solidyn Solutions, Incorporated (SSI)
South Central Michigan Works
South Georgia State College
South Street Elementary School
South University
Southern Illinois University STEM Education Research Center
SparkFun Electronics
Spartan College of Aeronautics and Technology
SPIE, the International Society for Optics and Photonics

Spiral Design ELEMENTS
Spirit of Joy Ministries, Inc. Dream Center
Spring Hill Elementary School
St. Mary's Episcopal School
Stamford Youth Foundation, Odyssey of the Mind Program
STARBASE ROBINS
State Supervisors for Technology Education
STEAM Fab
STEM + Youth
STEM Education Center at Worcester Polytechnic Institute (WPI)
STEM Education Leader
STEM Fuse
STEM Gharbiya
STEM Girl, Inc.
STEM Innovations
STEM Revolution
STEM Travel Club, LLC
STEMedia
Stemgarten Academy
STEMtastic
STEMulation Learning Systems, Inc.
STEMulations Learning Systems, Inc.
STEMulus Educational Consulting LLC
Stuart Hall School for Boys
Students 2 Science, Inc.
Students4STEM
SUNY Binghamton
Sustainablelearning, Inc.
Synapse Science & Technology Learning Center
TASC
Teachers Who Tech
Teaching Garage
TeachingJobs.com
TechGirlz
TechGYRLS YWCA
Techno Chaos
TechnoB Consultancy Services
Technology Education Association of Massachusetts
Technology Education Mount Savage Middle School
Technology Student Association
TechScool
TeenLife Media
Teens4Oceans
Ten80 Education
Tennessee Junior Acadmay of Science
TERC
Texas Academy of Mathematics and Science
Texas Girls Collaborative Project

Texas Instruments
The 21st Century Partnership for STEM Education
The Academy of Medicine, Engineering and Science of Texas
The American Council of STEM Educators
The Banff School
The Botanical Society of America
The Business Roundtable
The Catalyst Collective, Inc
The Collegiate Inventors Competition
The Federation of Associations in Behavioral, Psychological, & Cognitive Sciences
The GLOBE Program
The Growing Room Education Council
The Kessler School
The Laboratory Chicago
The Learning and STEM Specialist
The McGraw-Hill Companies
The National Academy of Future Physicians and Medical Scientists
The National Academy of Future Scientists and Technologists
The Optical Society
The Peterson Group
The Rights 2 Life Foundation, Inc.
The Stern Group
The Warren A. Sill Fund
Thinkerella
ThotWave Technologies LLC
Tidewater Tech Trades
TIES
Tiffin Columbian High School
Times2 STEM Academy
Touch Development Cooperative
Touro College of Pharmacy
Transatlantic Outreach Program
Trenton Public Schools
TRI Princeton
Triangle Coalition
Trion City Schools, Trion, GA
TTT Mentor Program
Tuscarora Intermediate Unit 11
Tutor Me This
29 high
U.S Chamber of Commerce Institute for a Competitive Workforce
U.S. Chamber of Commerce
UC Berkeley Pre-College TRIO Programs
Union City Board of Education
United 4 Support Inc.
United Negro College Fund
United States Society of Dams
Unity Learning Network, Inc.

University of Arkansas, Center for Math and Science Education(CMASE)
University of Buffalo
University of California
University of California, Berkeley
University of Central Florida TRiO Center
University of Glascow
University of Houston STEM Center
University of Kansas
University of Louisville Department of Environmental Health and Safety
University of Maryland
University of Michigan
University of Nevada Cooperative Extension 4-H Youth Development Program
University of North Carolina, Charlotte
University of Texas Medical Branch, Southeast Regional Texas STEM Center
Unlimited Tomorrow
Upper Dublin School District
UTeachEngineering
Utica Community Schools
Van Scoyoc Associates, Inc.
Velleman Store
Vernier Software & Technology
Versor Systems
Veterans Environmental Consulting
VILC Schools
Virginia Association of Science Teachers
Virginia Science Education Leadership Association
Virginia Tech's VT STEM K-12 Outreach Initiative
Vivify
Voces Verdes
Volanz Aerospace Inc. / Spaceflight Institute
Volunteer Center at united Way of Tucson and Southern Arizona
Washington Partners
Water Environment Federation
Watertown City School District
WaterVentures Florida's Learning Lab
Watt Nxt
WeBridge Education
Webtech IT
Webucator
WEE Care Juvenile Success Program
West Shore Community College
WGBH Teachers' Domain
Wheatland Union High School
Whitman Able Consulting
Widmeyer Group
Will Rogers Learning Community
Wisconsin Society of Science Teachers
Wisdom Tools

Women in Engineering Programs & Advocates Network, Inc.
Wood Group
Wood Rodgers Inc.
Words and Numbers
Xavier University
Xenia Community Schools
Xprize
Yaskawa America, Motoman Robotics Division
YES THRIVE
Yough School District-Educator
Young Adult Library Services Association
Young Athletes Foundation
Young Professional Institute
Young Scholars
Zaniac
Zozude, LLC
zSpace, Inc.
The Space Foundation
SpaceX
Blue Origin
MacArthur Foundation
North Carolina School of Science and Mathematics
MathCounts
National Math + Science Initiative (NMSI)
USA Science & Engineering Festival (USASEF)
Raytheon - Education
Northrup Grumman - Education

There were 292 higher educational institutions found to have degrees or fields in STEM offered at their schools as shown in table A11.

Table A11

List of Higher Education Institutions with STEM fields at institution

Name of Higher Educational Institution
Air Force Academy (Military Academy)
Air Force Institute of Technology
Alabama A&M University
American University
Arizona State University (Main Campus)
Arizona State University West
Asbury College
Auburn University
Baylor University
Bennett College
Boston University
Bowie State Univerisity

Brandeis University
Brigham Young University
Brigham Young University Idaho Campus (formerly Ricks College)
Brown University
Bucknell University
Cal Berkeley
Cal State LA
Cal State Long Beach
Cal State Northridge
Cal State San Bernardino
California Baptist
California Institute of Technology
California Polytechnic State University
California State Polytechnic University at Pomona
California State University-Chico
Canisius College
Capitol College
Carnegie Mellon University (PA)
Case Western Reserve University (OH)
Catholic University
Catholic University of America
Cedarville University
City College of San Francisco
Clark Atlanta University
Clarkson University (NY)
Clemson University (SC)
College of Charleston
College of William and Mary
Colorado School of Mines
Colorado State University
Colorado State University
Colorado State University - Fort Collins
Columbia University
Cornell University (NY)
Creighton University
CSU Monterey Bay (not ABET)
Dartmouth College
Del Mar College
Delaware State University
DePaul University
Drexel University (PA)
Duke University (NC)
East Carolina
Eastern Washington University
Embry-Riddle Aeronautical University
Fayetteville State
Fielding University
Florida A&M
Florida Atlantic University
Florida Institute of Technology
Florida State University
George Mason University
George Washington University
Georgia Institute of Technology

Hampton University
Hanover College
Harding University Main Campus
Hartnell College (not ABET)
Hood College
Hope College
Howard (DC)
Illinois Institute of Technology
Indiana University of Pennsylvania
Indiana University-Purdue University Indianapolis
Iowa State University
Jackson State University
James Madison University
Johns Hopkins University (MD)
Kansas State University
Keck Graduate Institute of Applied Life Sciences
Kent State University (Main Campus)
Lehigh University (PA)
LeTourneau University
Liberty University
Lousianna State University
Loyola Marymount (LA)
Loyola Marymount University
Massachusetts Institute of Technology
McDaniel College
Messiah College
Michigan State University
Michigan Technological University
Mississippi State University
Missouri University of Science and Techonology
Montana State University at Bozeman
Monterey Peninsula College (not ABET)
Morgan State (MD)
Mount St. Mary's College and Seminary
National University (SD)
Naval Academy (Military Academy)
Naval Postgraduate School
New Jersey City University
New Jersey Institute of Technology
New Mexico Institute of Mining and Technology
New Mexico State University
New York University
Norfolk State University
North Carolina A&T
North Carolina State
North Carolina State University
North Dakota State University
Northrop University
Ohio State University
Oklahoma State University
Old Dominion University
Oregon State University
Our Lady of the Lake University
Pennsylvania State University

Pennsylvania State University at University Park
Polytechnic Institute of New York University
Prairie View A&M
Princeton University (NJ)
Providence College
Purdue University—West Lafayette (IN)
Rensselaer Polytechnic Institute (NY)
Rice University (TX)
Rochester Institute of Technology
Rose-Hulman Institute of Technology
Rowan University
Rutgers University
Sam Houston State University
San Diego State University
San Francisco State
San Jose State
Santa Clara University
Scripps Institute of Oceanography
Seattle University
Smith College
Southeastern University
Southern Methodist University
Southern Polytechnic State University
Southern University and A&M College (Baton Rouge, LA)
Southern University and Agricultural and Mechanical College
Southwestern College
St. Louis University
St. Mary's (San Antonio)
St. Mary's University
Stanford University (CA)
State University of New York at New Paltz
State University of New York Maritime College
Stevens Institute of Technology (NJ)
SUNY College of Environmental Science and Forestry (NY)
Sweet Briar College
Syracuse University
Temple University
Tennessee State University
Texas A&M Corpus Christi
Texas A&M Galveston
Texas A&M Kingsville
Texas A&M University
Texas A&M University at Corpus Christi
Texas A&M University—College Station
Texas Christian University
Texas Southern
Texas State University
Texas Tech University
The Catholic University of America
The College of New Jersey
Towson University
Trinity University (San Antonio)
Tufts University
Tulane

Tulane University
Tuskegee (AL)
UC Davis
UC Irvine
UC Riverside
UC San Diego
UC Santa Barbara
UC Santa Cruz
UCLA
UNC Chapel Hill
UNC Greensboro
Univ of California, San Diego
Univeristy of Central Florida
University of Akron
University of Alabama
University of Alabama at Birmingham
University of Alabama in Huntsville
University of Alaska
University of Arizona
University of Arkansas
University of Arkansas at Little Rock
University of California at Berkeley
University of California at Davis
University of California at Los Angeles
University of California at San Diego
University of California at Santa Barbara
University of California—Berkeley
University of California—Davis
University of California—Irvine
University of California—Los Angeles
University of California—San Diego
University of Central Florida
University of Chicago
University of Colorado
University of Colorado at Boulder
University of Colorado at Colorado Springs
University of Connecticut
University of Dayton
University of Florida
University of Georgia
University of Hawaii
University of Houston
University of Idaho
University of Illinois
University of Illinois at Chicago
University of Illinois at Urbana-Champaign
University of Iowa
University of Kansas
University of Kentucky
University of Louisville
University of Maine
University of Maryland College Park (MD)
University of Maryland in Baltimore County
University of Maryland University College

University of Miami
University of Michigan at Ann Arbor
University of Minnesota - Twin Cities
University of Minnesota at Duluth
University of Mississippi
University of Missouri - Columbia
University of Nebraska – Lincoln
University of Nevada at Las Vegas
University of Nevada at Reno
University of New Hampshire
University of New Mexico
University of North Carlina at Charlotte
University of North Carolina at Chapel Hill
University of North Carolina at Charlotte
University of North Dakota
University of North Texas
University of Northern Iowa
University of Notre Dame
University of Oklahoma at Norman
University of Oregon
University of Pennsylvania
University of Pittsburg
University of Rhode Island
University of Rochester (NY)
University of San Diego
University of South Florida
University of Southern California
University of Southern Mississippi
University of Texas at Arlington
University of Texas at Arlington
University of Texas at Austin
University of Texas at Dallas
University of Texas at El Paso
University of Texas Austin
University of Texas San Antonio
University of Tulsa (OK)
University of Utah
University of Vermont
University of Virginia
University of Washington
University of West Florida - Northwest Florida State College
University of West Georgia
University of Wisconsin at La Crosse
University of Wisconsin at Madison
University of Wyoming
Utah State University
Valparaiso University
Vassar College
Villanova University
Virginia Commonwealth University
Virginia Military Institute
Virginia Polytechnic Institute and State University
Virginia State University
Virginia Tech (VA)

Washington State University
Washington University at St. Louis
Wayne State University
West Point (Military Academy)
West Virginia University
Western Michigan University
Winston-Salem State
Worcester Polytechnic Institute (MA)
Wright State University
Yale University

Appendix E: List of Federal STEM Initiatives

The following is a list of federal STEM initiatives:

National Aeronautics and Space Administration
- Minority University Research and Education Project (MUREP)
- National Space Grant College and Fellowship Project (Space Grant)
- STEM Education and Accountability Project (SEAP)

National Science Foundation
- Advanced Technological Education (ATE)
- Advancing Informal STEM Learning (AISL)
- Alliances for Graduate Education and the Professoriate (AGEP)
- Cultivating Cultures for Ethical STEM (CCE STEM)
- CyberCorps(R): Scholarship for Service (SFS)
- Discovery Research PreK-12 (DRK-12)
- East Asia & Pacific Summer Institutes for U.S. Graduate Students (EAPSI)
- Education and Human Resources Core Research (ECR)
- Graduate Research Fellowship (GRF) Program
- Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)
- Improving Undergraduate STEM Education (IUSE)
- Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES)
- International Research Experiences for Students (IRES)
- Louis Stokes Alliances for Minority Participation (LSAMP)
- National Science Foundation Research Traineeship (NRT)
- Research Experiences for Teachers (RET) in Engineering and Computer Science
- Research Experiences for Undergraduates (REU)
- Robert Noyce Teacher Scholarship Program
- STEM + Computing (STEM+C) Partnerships
- Tribal Colleges and Universities Program (TCUP)

Nuclear Regulatory Commission
- Integrated University Program (IUP)
- Minority Serving Institutions Program (MSIP)

Department of Agriculture
- Animal and Plant Health Inspection Service
  - AgDiscovery Program
  - National Scholars Program
- National Institute of Food and Agriculture
  - 1890 Institution Teaching, Research and Extension Capacity Building Grants (CBG) Program
  - Agriculture and Food Research Initiative Education and Literacy Initiative Research and Extension Experiences for Undergraduate Fellowships

  - Agriculture and Food Research Initiative Education and Literacy Initiative Professional Development for Secondary School Teacher and Education Professionals
  - Agriculture and Food Research Initiative Fellowships (Predoctoral and Postdoctoral)
  - Agriculture in the Classroom
  - Distance Education Grants Program for Institutions of Higher Education in Insular Areas
  - Higher Education Challenge Grants Program
  - Hispanic Education Partnership Grants
  - Multicultural Scholars
  - National Needs Fellowships
  - Secondary Education, Two-Year Postsecondary Education and Agriculture in the K-12 Classroom Grants
  - Resident Instruction Grants Program for Institutions of Higher Education in Insular Areas
  - Women and Minorities in Science, Technology, Engineering and Mathematics Fields Grant Program (WAMS)

Department of Commerce

- National Institute of Standards and Technology (NIST)
  - NIST Summer Institute for Middle School Science Teachers
  - NIST Graduate Student Measurement Science & Engineering (GMSE) Fellowship Program
  - NIST Summer Undergraduate Research Fellowship (SURF) Program
- National Oceanic and Atmospheric Administration (NOAA)
  - Bay Watershed Education and Training (B-WET) Program
  - Environmental Literacy Program
  - Educational Partnership Program with Minority Serving Institutions
  - Ernest F. Hollings Scholarship Program
  - National Sea Grant College Program (National Sea Grant College Program-Education Component)
  - Teacher at Sea Program

Department of Defense

- Air Force
  - Air Force K-12 STEM Outreach (AFSTEM)
  - National Defense Science and Engineering Graduate (NDSEG) Fellowship
- Army
  - Army Educational Outreach Program (AEOP)
- Navy
  - Science and Engineering Apprentice Program (SEAP)
  - SeaPerch
  - The Naval Research Enterprise Intern Program (NREIP)

Secretary of Defense

- DoD STARBASE Program
- Junior Reserves Offices Training Corps (JROTC) Program*
- National Defense Education Program (NDEP) Military Child Pilot Program

- National Defense Education Program (NDEP) K-12
- National Defense Education Program (NDEP) Science, Mathematics And Research for Transformation (SMART)

Department of Education

- Developing Hispanic-Serving Institutions: STEM and Articulation Programs
- Graduate Assistance in Areas of National Need
- Mathematics and Science Partnerships
- Minority Science and Engineering Improvement Program
- Research in Special Education
- Research, Development, and Dissemination
- Strengthening Predominantly Black Institutions

Department of Energy

- Advanced Vehicle Competitions
- American Chemical Society Summer School in Nuclear and Radiochemistry
- BioenergizeME
- Collegiate Wind Competition
- Community College Internships (CCI)
- Computational Science Graduate Fellowship
- Environmental Management-Minority Serving Institution Partnership Program (MSIPP)
- Environmental Management Traineeship in Robotics
- Hampton University Graduate Studies
- Industrial Assessment Centers
- Integrated University Program (IUP)
- Mickey Leland Energy Fellowship Program
- Minority Educational Student Partnership Program (MEISPP) (summer interns)
- National Nuclear Security Administration-Minority Serving Institutions Partnership Program
- National Science Bowl (NSB)
- Office of Science Graduate Student Research (SCGSR)
- Race to Zero Student Design Competition
- Radiochemistry Summer School
- Science and Technology Workforce Development Initiative
- Science Undergraduate Laboratory Internships (SULI)
- Solar Decathlon
- Traineeship in Radiochemistry
- Visiting Faculty Program (VFP)

Department of Health and Human Services

- National Institutes of Health
    - Aging Research Dissertation Awards to Increase Diversity
    - Blueprint Program for Enhancing Neuroscience Diversity through Undergraduate Research Education Experiences
    - Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative: Short Courses in Computational Neuroscience
    - Bridges to the Baccalaureate Program

- Bridges to the Doctorate
- Cancer Education Grants Program
- Cancer Research Education Grants Program-Research Experiences
- Center for Cancer Research Cancer Research Interns (Cancer Research Interns)
- Center for Cancer Research/John Hopkins University Master of Science in Biotechnology Concentration in Molecular Targets and Drug Discovery Technologies
- Courses for Skills Development in Biomedical Big Data Science
- Drug Abuse Dissertation Research
- Enriching the Hematology Research Workforce through Short-term Educational Experiences in Emerging Science Research Education Program Grant
- Graduate Partnerships Program
- Initiative for Maximizing Student Development
- Initiative to Maximize Research Education in Genomics: Diversity Action Plan
- Innovative Programs to Enhance Research Training (IPERT)
- Intramural National Institute of Allergy and Infectious Diseases Research Opportunities
- Maximizing Access to Research Careers (MARC) U-STAR
- Medical Informatics Training Program
- Mental Health Research Dissertation Grant to Increase Diversity
- National Cancer Institute Predoctoral to Postdoctoral Fellow Transition Award (F99 portion only)
- National Institute of Allergy and Infectious Diseases Division of Intramural Research (DIR) Office of Training and Diversity (OTD) Sponsorship Program
- National Institute of Allergy and Infectious Diseases Division of Intramural Research (DIR) Summer Diversity Program
- National Institute of Diabetes and Digestive and Kidney Diseases Research Education Program Grants for Summer Research Experiences (R25)
- National Institute of Mental Health Mentoring Networks for Mental Health Research Education
- National Institute of Mental Health Research Education Mentoring Programs for HIV/AIDS Research
- National Institute of Mental Health Short Courses for Mental Health-Related Research Education
- National Institute of Neurological Disorders and Stroke Neuroscience Development for Advancing the Careers of a Diverse Research Workforce
- National Institute of Nursing Research Summer Genetics Institute
- National Institute on Aging Medicine, Science, Technology, Engineering and Mathematics: Advancing Diversity in Aging Research (ADAR) through Undergraduate Education
- National Library of Medicine Institutional Training Grants for Research Training in Biomedical Informatics and Data Science
- NIH Big Data to Knowledge (BD2K) Enhancing Diversity in Biomedical Data Science
- NIH Building Infrastructure Leading to Diversity (BUILD) Initiative (RL5 portion only)

- NIH Building Infrastructure Leading to Diversity (BUILD) Initiative (TL4 portion only)
- Postbaccalaureate Intramural Research Training Award Program
- Postbaccalaureate Research Education Program (PREP)
- Research Education Grants for Statistical Training in the Genetics of Addiction
- Research Initiative for Scientific Enhancement
- Research Supplements to Promote Diversity in Health-Related Research
- Ruth L. Kirschstein National Research Service Award Institutional Research Training Grants (T32, T35, T90, TL1)
- Ruth L. Kirschstein National Research Service Award for Individual Predoctoral Fellows, including Underrepresented Racial/Ethnic Groups and Students from Disadvantaged Backgrounds
- Science Education Drug Abuse Partnership Award
- Science Education Partnership Award
- Short Courses on Mathematical, Statistical, and Computational Tools for Studying Biological Systems
- Short-Term Research Education Program to Increase Diversity in Health-Related Research
- Short-Term Research Experience for Underrepresented Persons (STEP-UP; R25)
- Student Intramural Research Training Award Program
- Summer Institute for Research Education in Biostatistics
- Summer Research Education Experience Programs
- Team-Based Design in Biomedical Engineering Education
- Training in Computational Neuroscience: From Biology to Model and Back Again (R90 portion only)
- Undergraduate Research Education Program (UP) to Enhance Diversity in the Environmental Health Sciences
- Undergraduate Scholarship Program for Individuals from Disadvantaged Backgrounds
- Undergraduate Summer Institutes in Kidney, Urologic and Hematologic Diseases (R25)

Department of Homeland Security

- Science and Technology Directorate
  - Homeland Security STEM Summer Internship Program
  - Minority Service Institutions-Scientific Leadership Awards
  - Minority Service Institutions-Summer Research Team

Department of the Interior

- U.S. Geological Survey
  - Education Component of the National Cooperative Geologic Mapping Program (EDMAP)
  - National Association of Geoscience Teachers (NAGT)-USGS Cooperative Summer Field Training Program
  - Student Intern in Support of Native American Relations (SISNAR)
- Bureau of Indian Affairs
  - Bureau of Indian Affairs, Office of Trust Services, Pathways Internship Program
  - Science Post Graduate Scholarship Fund

Department of Transportation

- Office of the Secretary of Transportation
  - University Transportation Centers Program
- Federal Aviation Administration
  - Joint University Program
- Federal Highway Administration
  - Garrett A. Morgan Technology and Transportation Education Program
  - National Summer Transportation Institute
  - Summer Transportation Internship Program for Diverse Groups
- Environmental Protection Agency
  - Cooperative Training in Environmental Sciences Research
  - Environmental Education Grants Program
  - Environmental Research Training Grant (University of Cincinnati/EPA Research Training Grant)
  - National Environmental Education Program
  - People, Prosperity, and Planet Award: National Student Design Competition for Sustainability
  - President's Environmental Youth Award

Source: GAO-18-290 and NSTC (2011). The Federal STEM Education Portfolio. http://www.whitehouse.gov/sites/default/files/microsites/ostp/costem__Federal_stem_education_portfolio_report.pdf.
Note: *JROTC was not included in the GAO-18-290 list of STEM programs because the primary program objective is not STEM education.

Appendix F: Sample list of Federal STEM Authorities

The following is a sample list of federal STEM authorities that provide guiding principles for programs and initiatives within federal agencies. Please note this is not a mutually exclusive, nor a collectively exhaustive list:

Department of Defense Diversity and Inclusion Strategic Plan 2012-2017, http://diversity.defense.gov/Portals/51/Documents/DoD_Diversity_Strategic_Plan_%20final_as%20of%2019%20Apr%2012%5B1%5D.pdf

Department of Education. Race to the Top. http://www2.ed.gov/programs/racetothetop/index.html

Department of Education. Innovation. http://www2.ed.gov/programs/innovation/index.html

Deputy Secretary of Defense Memorandum, "Delegation of Authority Relating to Support of Science, Technology, Mathematics and Engineering Education," June 25, 2010

Deputy Secretary of Defense Memorandum, "Implementation Guidance for the Establishment of the Office of the Under Secretary of Defense for Research and Engineering and the Office of the Under Secretary of Defense for Acquisition and Sustainment," January 31, 2018

DoD 7000.14-R, Volume 5, "Department of Defense Financial Management Regulation: Disbursing Policy," current edition

DoD Instruction 1205.13, "Junior Reserve Officers' Training Corps (JROTC) Program," February 6, 2006

DoD Directive 5134.3, "Director of Defense Research and Engineering (DDR&E)," November 3, 2003

DoD Directive 5124.02, "Under Secretary of Defense for Personnel and Readiness USD(P&R))," June 23, 2008

DoD Directive 5134.01, "Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L))," December 9, 2005, as amended

DoD Instruction 1100.21, "Voluntary Services in the Department of Defense," March 11, 2002, as amended

DoD Instruction 8910.01 "Information Collection and Reporting," May 19, 2014

DoD Manual 8910.01, Volume 1, "DoD Information Collections Manual: Procedures for DoD Internal Information Collections," June 30, 2014, as amended

DoD Manual 8910.01, Volume 2, "DoD Information Collections Manual: Procedures for DoD Public Information Collections," June 30, 2014, as amended

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National Research Council. (2010). NOAA's Education Program: Review and Critique. Committee for the Review of the NOAA Education Program. J.W. Farrington and M.A. Feder, Editors. Board on Science Education. Washington, DC: The National Academies Press.

Office of Personnel Management Memorandum, "Participation of Federal Employees in Volunteer Activities," April 23, 1998

Public Law 111-352, "The GPRA Modernization Act of 2010," January 4, 2011 (http://www.gpo.gov/fdsys/pkg/BILLS-111hr5116enr/pdf/BILLS-111hr5116enr.pdf)

Public Law 111-358, "America COMPETES Reauthorization Act of 2010," January 4, 2011 (http://www.gpo.gov/fdsys/pkg/BILLS-111hr5116enr/pdf/BILLS-111hr5116enr.pdf)

Under Secretary of Defense for Acquisition, Technology and Logistics Memorandum, "Delegation of Authority Memorandum to the Director, Defense Research and Engineering," October 12, 2010

United States Code, Title 10

U.S. Department of Commerce (January, 2012). The competitiveness and innovative capacity of the United States. http://www.commerce.gov/sites/default/files/documents/2012/january/competes_010511_0.pdf.

U.S. Government Accountability Office, GAO-12-208G, "Designing Evaluations," January 2012, https://www.gao.gov/products/GAO-12-208G

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