MODELING AN EDUCATION TO EMPLOYMENT COLLECTIVE IMPACT STRATEGY FOR SCIENCE, TECHNOLOGY, ENGINEERING AND MATH FOR ECONOMICALY DISADVANTAGED STUDENTS IN NEW YORK STATE

A thesis presented by

Shai Leynette Butler

To

Doctor of Law and Policy Program

In partial fulfillment of the requirements for the degree of Doctor of Law and Policy

College of Professional Studies
Northeastern University
Boston, Massachusetts
July 2014
Modeling an Education to Employment Collective Impact Strategy for Science, Technology, Engineering and Math for Economically Disadvantaged Students in New York State

by Shai L. Butler

COPYRIGHT 2014
DEDICATION

I dedicate this work first and foremost to God, for had it not been for His grace this achievement would not have been possible. This work is also dedicated to a number of people who supported me during this journey. My mom, Tondra Ruth Taylor Brown, was a guiding force in my life and a living example of wisdom, perseverance, diligence, humility, grace and love. Mom, you started with me on this journey and though you now rest in the arms of God you remain with me still. I am thankful that you were able to see into the future and know that in spite of your absence in body, the end would still be achieved. You told me it must. Therefore, I dedicate this to the woman who believed in me first and most.

My husband, Odo Naku Butler, my Boaz and kinsman redeemer on Earth, I dedicate this work to you. We were destined for one another and I am glad that I had the good sense to say, “Yes,” to the wonderful gift of God that is you. To my children, Chantelle, Koa, and Nori, Mom is so proud to be able to leave you this legacy. However important knowledge is, wisdom is better. Through faith and hard work you can achieve anything. Always remember, that I love you and that the fear of the Lord is the beginning of wisdom (Proverbs 9:10).

This is also dedicated to my village—the family and friends who have loved, supported, motivated, cheered, cried, prayed, and believed in me throughout this process. Thank you for the grace and the space to reach this goal. You each inspire me in so many different ways. I love you all.
ACKNOWLEDGEMENTS

“…being confident of this, that He who began a good work in you will carry it on to completion until the day of Christ Jesus.” Philippians 1:6

Thank you to my doctoral thesis advisor, Kristen Lee Costa. Without your expertise, guidance and mentorship I would never have completed this work. To my program advisor, Neenah Estrella-Luna, MPH, PhD and my second reader, Robert James, Vice Provost of Opportunity Programs for the State University of New York (retired) thank you both so much for the advice, candor, and support as you helped to shepherd this work. To Cohort VI, the Dream Team of the Doctorate of Law and Policy Program, you made this a memorable and fun journey. To the faculty in the College of Professional Studies who laid the foundation, Program Director Dan Urman, for his leadership and James Passinisi for being an administrator extraordinaire, I thank you.

Thank you to all of the study participants who gave willingly of their time to support this research endeavor. I appreciate the support of my colleagues at the College of Saint Rose who encouraged me along the way. I am thankful to my pastor, the Reverend Dr. Damone Paul Johnson and his wife Angela Johnson who served as spiritual mentors and role models; they encouraged and inspired me to do great things.

Finally, thank you to all of the women in the world who “Lean In” daily and the men who cheer them on…
ABSTRACT

Educational inequalities in our nation’s schools have perpetuated systemic intergenerational poverty. Expanding STEM college and career opportunities has been established as one approach to improving economic mobility for low socioeconomic students and efficiency in regional market industries. As global demands for human capital increases to fill anticipated STEM jobs, Cradle to Career and P-16 pipeline partnership programs are well positioned to respond to calls for a skilled workforce. This study explores STEM and other educational programs and policies that provide evidence of successful outcomes and promising practices. The purpose of this research is to develop new approaches to funding, graduating, and employing economically disadvantaged students in New York State who are pursuing STEM majors and careers.

This qualitative study used semi-structured interviews, document reviews, and web analysis to research funding opportunities, evidenced-based practices and models for new partnerships for implementation in scaling existing STEM initiatives for New York State. The findings affirm the need for partnerships designed to respond with complex interventions for collective impact in closing the achievement gap for New York’s students from low socioeconomic households. In response a collective impact model was designed based upon study recommendations and best practices identified in the research. The model used the National Football League’s organizational structure as a framework for implementation. It offers policy makers, educators and practitioners a unifying design for change management and a guide for implementation.
# TABLE OF CONTENTS

**Chapter 1: Introduction** ........................................................................................................... 8
- Policy Problem ................................................................................................................................. 10
- Significance........................................................................................................................................ 11

**Chapter 2: Literature Review** .................................................................................................... 16
- Educational Equity and Efficiency ...................................................................................................... 19
- Public-Private Educational Partnerships .......................................................................................... 31
- Summary ........................................................................................................................................... 32

**Chapter 3: Methodology** ............................................................................................................ 33
- Research Design ................................................................................................................................. 36
- Data Analysis .................................................................................................................................... 38

**Chapter 4: Results** ..................................................................................................................... 39
- Research Question 1 ......................................................................................................................... 41
- Research Question 2 ......................................................................................................................... 52
- Research Question 3 ......................................................................................................................... 73

**Chapter 5: Findings, Recommendations and Conclusions** ...................................................... 81
- Research Question 1 ......................................................................................................................... 79
- Research Question 2 ......................................................................................................................... 84
- Research Question 3 ......................................................................................................................... 89

**References** ................................................................................................................................... 103

**Appendix A** ................................................................................................................................. 122

**Appendix B** .................................................................................................................................. 124

**Appendix C** ................................................................................................................................... 124
LIST OF TABLES

Table 1: Poverty Issues Impacting STEM Education K-12 by Topic & Interview Participant...71
Table 2: Table 2 Summary of Study Results by Research Question:.............................79
Table 3: Findings & Recommendations for Research Question 1:.................................99
Table 4: Findings & Recommendations for Research Question 2:..................................100
Table 5. Findings & Recommendations for Research Question 3:....................................101
# LIST OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>American College Testing</td>
</tr>
<tr>
<td>CICU</td>
<td>Commission on Independent Colleges and Universities</td>
</tr>
<tr>
<td>CO-OP</td>
<td>Cooperative Education Program</td>
</tr>
<tr>
<td>CSTEP</td>
<td>Collegiate Science and Technology Entry Program</td>
</tr>
<tr>
<td>CUNY</td>
<td>City University of New York</td>
</tr>
<tr>
<td>DOE</td>
<td>United States Department of Education</td>
</tr>
<tr>
<td>ELA</td>
<td>English Language Arts</td>
</tr>
<tr>
<td>EOP</td>
<td>Educational Opportunity Program</td>
</tr>
<tr>
<td>FAFSA</td>
<td>Free Application for Federal Student Aid</td>
</tr>
<tr>
<td>FRLP</td>
<td>Free and Reduced Lunch Program</td>
</tr>
<tr>
<td>GRE</td>
<td>Graduate Record Exam</td>
</tr>
<tr>
<td>K-12</td>
<td>Kindergarten through Twelfth Grade</td>
</tr>
<tr>
<td>NFL</td>
<td>National Football League</td>
</tr>
<tr>
<td>NYSAN</td>
<td>New York State Afterschool Network</td>
</tr>
<tr>
<td>NYSED</td>
<td>New York State Education Department</td>
</tr>
<tr>
<td>P-16</td>
<td>Pre-school through a four year college degree program</td>
</tr>
<tr>
<td>P-CAST</td>
<td>President's Council of Advisors on Science and Technology</td>
</tr>
<tr>
<td>P-TECH</td>
<td>Pathways in Technology Early College High Schools</td>
</tr>
<tr>
<td>REDC</td>
<td>Regional Economic Development Council</td>
</tr>
<tr>
<td>RFP</td>
<td>Request for proposal</td>
</tr>
<tr>
<td>SAT</td>
<td>Scholastic Aptitude Test</td>
</tr>
<tr>
<td>SEEK</td>
<td>Search for Education, Elevation, and Knowledge</td>
</tr>
<tr>
<td>SES</td>
<td>Socioeconomic Status</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Math</td>
</tr>
<tr>
<td>STEP</td>
<td>Science and Technology Entry Program</td>
</tr>
</tbody>
</table>
Chapter 1

Introduction

We live in unprecedented times when access to higher education is at the highest level in history. Instead of increased access leading to upward mobility for those in the lower socioeconomic status (SES) groups, educational policies and practices have further perpetuated income inequality and widened the existing achievement gap (Carnevale, 2010; Carnevale & Strohl, 2013; Rothstein, 2011; US Department of Education, 2012). Existing income inequality is impacted by rising rates of underemployment, unemployment and increasing student loan debt for college attendees and graduates (Federal Reserve, 2012; Reed & Cheng, 2009; Stone, Horn, & Zukin, 2012; The Institute for College Access and Success, 2012). A review of the research on educational inequality, established that when national data is disaggregated by race and socioeconomic status, the gaps between underrepresented minorities, and economically disadvantaged students in comparison to middle and upper class white students highlight the disparity between higher educational access and degree completion (Elliott & Friedline, 2013; Kim, 2012; US Department of Education, 2012).

As global demands for workers in the science, technology, engineering, and math (STEM) fields persist, opportunities for economically disadvantaged and underrepresented minorities to fill STEM positions increase. To develop an employment pipeline with collective impact, a comprehensive model of scale that addresses issues associated with inequality and inefficiency resulting from the widening educational achievement and employment gaps within the state of New York is needed.

Horace Mann, the first Secretary of Education for Massachusetts was a strong advocate for education of the common man. Mann is well-known for his description of education as the “great equalizer.” Despite Mann’s assertion, there is no national right to an education written
within the United States Constitution. However, education has been designated as a right within all fifty states of the Union including New York. Specifically, Article XI of the New York State Constitution decrees, “The legislature shall provide for the maintenance and support of a system of free common schools, wherein all the children of this state may be educated” (NY Const. art. XI, § 9, cl. 2.). It goes on to state that the attainment of education without discrimination is a Civil Right under NY EXC. LAW § 291: NY Code - Section 291.

In addition to being a right, education is also described as a public good—neither excludable nor rivaled in consumption. Individuals cannot be prevented from the use of a public good, nor can an individual’s utilization be reduced. Public education is a public good, while higher education is defined as an industry and is categorized as a highly subsidized private good (Mankiw, 2009). It is for this reason that market efficiency is of significant importance to consumers and producers of higher education. Individuals should have unobstructed access to higher education in order to support a healthy market. When individuals do not have such access, the market functions inefficiently. Market inefficiency has negative implications for the buyers, the sellers and the state. Likewise, when the market operates efficiently, there are positive outcomes for all stakeholders when equity is taken into consideration. Education can benefit the citizenry of New York by mutually advancing goals of equity and efficiency. Supporting the workforce development and employment of economically disadvantaged students aligns with these goals.

**Economically disadvantaged students.** The criteria used to determine students of low socioeconomic status (SES) are based upon eligibility for two federal government programs. At the K-12 level, students with low SES are defined by household qualification for participation in the federal Free and Reduced Lunch Program managed out of the US Department of Agriculture.
This income-based program provides school meals to economically disadvantaged students around the country. At the postsecondary level, students with low SES are defined based upon eligibility to qualify for a federal Pell Grant award. Pell awards are income-based government grants used toward costs associated with postsecondary education.

**Policy problem.** Systemic disparities in STEM education that disproportionately impact economically disadvantaged students result in inequality and inefficiency (Huang, 2013). Access to quality STEM education, funding for postsecondary education, retention, graduation, and employment are factors central to the current debate on the need for education reform at the K-12 and postsecondary levels (Conner & Rabovsky, 2011; Education Reform Act of 1993, 1993; Ravitch, 2000; Xiaodong, McInerney, & Frechtling, 2010). These disparities reflect the perspective of Nobel laureate economist Arthur M. Okun, as he describes the “double standard of a capitalist democracy where we profess and pursue an egalitarian political and social system and simultaneously generate gaping disparities in economic well-being” (Okun, 1975, p. 1). There is a need to identify approaches policymakers can use to structure STEM education in a way that addresses the impact of injustice. These innovative approaches to STEM can advance market efficiency at all levels of education while spurring statewide and regional economic growth.

Failure to create an employment pipeline for STEM will lead to economic inefficiency in labor markets in the United States that can stunt economic growth. The lack of a collective will and plan designed to address the inequality within the K-12 education system will foster continued inefficiencies in the higher education market. Research has shown that education is a mitigating factor for improving socioeconomic status (Wickrama, Simons, & Baltimore, 2012). Failure to address market inefficiencies and educational inequalities will negatively impact the
college to career pipeline for economically disadvantaged students—perpetuating generational poverty.

Given the extent of educational disparities in K-16 education, complexities associated with cross-industry collaboration, and the geographical specificity of STEM employment, solutions necessitate the need to uncover innovative educational approaches with maximum impact. Educational partnerships will benefit from including educators, government leaders, and the private sector. These partners should work collaboratively to identify scalable solutions that can improve the lives of New York’s most economically vulnerable. The following research questions are designed to help identify research, policies, and initiatives that will be the foundation of a model for implementation.

1. Research Question 1: What public-private funding programs can be developed to reduce costs and debt associated with college attendance for Pell-eligible STEM students in New York State?

2. Research Question 2: What policies and best practices can be developed from existing curricular and co-curricular programs to prepare students academically and professionally for postgraduate careers in STEM?

3. Research Question 3: What comprehensive public-private partnerships can be created or expanded to establish a large-scale career pipeline for STEM graduates in New York State?
Significance. Rising tuition costs, poor educational outcomes, as well as, under-employability and unemployment, have generated the need to explore new paradigms within higher education (Rothstein, 2011; Selingo, 2013; Stone et al., 2012). Government officials and consumers are calling for more transparency and accountability, thus increasing the need for higher education to reform existing policies and practices. These new mandates require an industry realignment that responds to regulatory calls for data-driven assessments and a more affordable path to degree attainment—one that meets students’ needs (Conner & Rabovsky, 2011; White House Press Secretary, 2013). If greater attention is given to these needs, there may be less of an urgency to address the ills associated with systemic inequality.

In “Separate and Unequal: How Higher Education Reinforces the Intergenerational Reproduction of White Racial Privilege,” Anthony Carnevale, economist and researcher at the Georgetown University Center on Education and the Workforce, exposes the systemic perpetuation of educational and income inequality (Carnevale & Strohl, 2013). Disparate employment outcomes based on educational inequality for students with low SES give rise to a need for a collective impact strategy of comprehensive efforts of scale to increase the number of economically disadvantaged students within the STEM pipeline. Scaling up the STEM talent pipeline is critical in order to meet the demands of the global economy and the United States’ employment needs. A report commissioned by the National Academy of Science claims that “the nation’s economic vitality is derived in large part from the productivity of well-trained people and the steady stream of scientific and technical innovations they produce” (The National Academy of Science, 2007).

New technologies, industry innovation, and high quality, content-specific jobs prevent STEM industry decline. Poised for growth, there is a need to develop a STEM employment
pipeline to address the anticipated labor shortages. The evidence points toward growing workforce needs by state and by industry. Citing the United States Department of Labor’s Bureau of Labor Statistics’ reports, the “Community College Review,” lists workforce shortages in manufacturing in Wisconsin, the health care industry in Illinois, and factory employment in Ohio. This data supports the more recent research indicating that the shortage of trained STEM workers is neither universal nor general (Hagedorn & Purnamasari, 2012). In keeping with this philosophy, New York’s Finger Lakes region developed a plan that called for fostering closer cooperation between the region’s companies and institutions of higher education to accelerate the transfer of technology and align workforce training programs with the skill sets required by the sector (NY Regional Economic Development Council, 2014).

New York’s approach to addressing the skills differentials among workers and industry segmentation that occur from geography and labor market shifts is to find regional solutions (NY Regional Economic Development Council, 2014). In 2011, New York’s governor, Andrew Cuomo, created 10 Regional Economic Development Councils for the purpose of geographically centralizing development efforts for maximum impact. The creation of these councils is one method for comprehensive, strategic, tailored solutions by industry, region, and state.

The formation of the Capital Region Economic Development Council’s Workforce and Education Work Group is a part of Governor Cuomo’s plan. The purpose of the work group is to “review workforce and education initiatives that impact economic development” (Capital Region Economic Development Council’s Work Groups, 2014). The work group’s creation reflects the need to expand access to higher education. This expansion is necessary, in part for the purpose of entry into the workforce, and places great pressure on the individual and the institutions to ensure college completion. Lessons learned from the economic recession of 2007 revealed that in
order to lift families out of poverty, education is crucial. Data from a study done at the Georgetown University Center on Education and the Workforce in years 2010 and 2011 indicate that college graduates fared better than less educated workers. Overall unemployment rates during this period were 9% to 10% for non-college graduates compared to 4.6% to 4.7% for college graduates 25 years of age or older (Carnevale & Strohl, 2013).

Research points to the fact that “the rate of return of a university education remains high, since the earnings differential associated with college has risen over the past several decades in tandem with fees, maintaining a high return on the financial investment” (Vedder, 2007, p. 6). Yet economists like Vedder, believe that government over invests in higher education and cites research that show a correlation between increasing state appropriations to higher education and declines in economic growth. Students who start but fail to complete college leave with debt and are less likely to earn wages comparable to those of college graduates. This condition increases the likelihood of default and indentured servitude—a term used to define the recent college graduate’s relationship with student loan debt. It was a phrase popularized by the media during the height of the economic recession and is still applicable today (Konczol, 2009; Rosenbaum, 2013). According to the Federal Consumer Financial Protection Bureau and other reports, student loan debt has ballooned to record levels outpacing credit card and other forms of debt to the amount of one trillion dollars (Consumer Financial Protection Bureau, 2013, Federal Reserve, 2012; Reed & Cheng, 2009; Rothstein, 2011). These studies affirm the need to develop and expand comprehensive solutions that connect improved higher education outcomes to employment in a way that reduces student debt and positively impacts regional economies.
Rising debt is directly contributing to a national policy problem of student loan default. Current students continue to borrow to finance education as former students lag, defer or default on payments. Defaulting on federal student loan debt negatively impacts not only the individual borrower, but also the government as guarantor and the American tax payer who picks up the tab for the unpaid debt. In addition, unemployment increases the likelihood of default, making success in the job market critical to repaying student loans (Solis, 2004; Thomason, 2013; Turner, 2012). This policy problem leads to inefficiencies in government, and the labor and higher education markets (Conner & Rabovsky, 2011; Federal Reserve, 2012; Vedder, Denhart, & Robe, 2013).

Existing wealth gaps within the nation are in part a result of the lack of quality education for economically disadvantaged students (Carnevale, 2010; Hallett & Venegas, 2011). College readiness leads to career readiness and both begin early in the academic careers of students (Miller & Kimmel, 2012). Particularly, if STEM educational inequality exists at the K-8 level, it becomes increasingly difficult to catch up at the secondary and postsecondary level (Chang, Sharkness, Hurtado, & Newman, 2014). In the 2014 State of the State Address, Governor Andrew Cuomo launched new initiatives that embrace STEM education and employment as a solution to closing the achievement and wealth gap, addressing current and future employment needs (Governor Andrew Cuomo, 2014). STEM is one vehicle that education, government and industry officials agree can be leveraged to address societal inequality and market inefficiency. What remains is the challenge of building a comprehensive scalable solution for these complex and diverse institutions. This research study offers a proposed model for application to address the need for collaborative public-private partnerships that advance STEM education and employment for economically disadvantaged students in New York State.
Chapter 2

Literature Review

Introduction

The literature review is divided into three areas of research. The first area includes research associated with educational inequality from a historical perspective to current issues. This approach includes the study of the broad application of equality to education in addition to a focus on STEM. The second body of literature focuses on aspects of efficiency in higher education and regional workforce development. The third area of research consists of a cursory review of public-private partnerships that support career and workforce development.

History of Educational Inequality

Educational inequalities by race and socioeconomic status in the nation’s schools date back to the country’s origin. Although founding fathers such as John Adams and Thomas Jefferson believed strongly in the education of the populace for the greater good of maintaining the Republic, this vision did not include the education of African slaves and women in the nation’s Common Schools (Hirsch, Jr., 2009; Jefferson, 1903-04; Noftsinger, Jr. & Newbold, Jr., 2007; Pidgin & Drown, 1899). Newly formed institutions of higher education in the United States were established for the nation’s elite, white males. Lucas, Noftsinger and Newbold wrote about Harvard’s 1636 founding and it being a place to “prepare men of refinement and culture, those destined to positions of responsibility and leadership in society” (Noftsinger, Jr. & Newbold, Jr., 2007).

Throughout America’s history, school segregation—by de jure and by de facto—has worked against the establishment of equal educational opportunities (Klarman, 2007; Rosenberg, 2008). While the past century has seen an expansion of educational opportunity at both the K-12
level and in higher education, the effects of historical injustice still reverberate (Lowe, 2004; McGough, 2004; Reardon, Baker, & Klasik, 2012).

In 1896, the United States Supreme Court ruled in Plessy v. Ferguson, legalizing race-based segregation and making “separate but equal” the law of the land (Caldas & Bankston, 2007). This decision was reversed in the 1954 Supreme Court ruling in Brown v. Board of Education and was intended to end school segregation (Klarman, 2002). There was a widely held belief that with the end of school segregation, the nation would witness a rise in educational equality. Instead, Brown v. Board had become an almost mythical symbol of American justice (Lowe, 2004).

Fifty years later, Brown has had little effect on bringing to fruition the promise of educational equality in the face of disparity (Klarman, 2007). Even in the states that did not openly defy the Supreme Court ruling, school districts were positioned to easily evade Brown. A number of school districts implemented superficial initiatives such as race-neutral neighborhood, freedom of choice, or open enrollment plans that easily allowed schools to remain segregated in practice (Oakes & Guiton, 1995). This type of de facto segregation has resulted in schools disproportionately resourced along lines of class. Exacerbating the issue, government tax structures that fund education at the local level allow wealthy districts to remain wealthy and poor districts to continue to operate without needed resources (Dayton, 1998; Lindjord, 2002).

The Schott Foundation documented discriminatory policies and practices based on race, poverty, and geography, in the city of New York. Research findings included evidence of education redlining. Underrepresented minorities and those with low income were being disproportionately tracked into an inferior educational experience based on geography, race and class status (Schott Foundation, 2012).
New York City is not alone, as the national demographics for schools in 2010 showed that 84% of White students attend a predominately White school (a school where at least 50% of the students were White), 46% of Black students attended a predominantly Black school, 56% of Hispanic students attended a predominately Hispanic school, 12% of Asians attended a predominantly Asian school, 13% of Pacific Islander students attended a predominantly Pacific Islander school and 23% of American Indian/Alaskan Native students attended a predominantly American Indian/Alaskan Native school. In addition, racial/ethnic patterns showed higher enrollment at high poverty schools for Blacks (41%), Hispanics (38%), American Indian/Alaskan Natives (31%) than lower numbers for Pacific Islanders (19%), bi/multi-racial students (16%), Asian (15%) and White students (6%) (US Department of Education, 2012b). Geographic concentrations of poverty and wealth correlate to the racial demographics of the nation. A class-stratified society continues the policies and practices of de facto and de jure segregation, which continue to negatively affect educational opportunities for those most economically vulnerable.

**Two federal criteria for defining economic disadvantage.** For the purpose of this study, students with low SES are defined as youth who come from low income households that qualify for the Federal Free and Reduced Lunch Program (FRLP). The program criteria are outlined by the United States Department of Agriculture (USDA) and were created to apply to students enrolled in public and private schools in grades K-12. Income eligibility guidelines are adjusted annually for FRLP and are based on the federal income poverty guidelines in conjunction with household size. The Department’s guidelines were obtained by multiplying the income poverty guidelines for 2014 by 1.30 and 1.85, respectively, and by rounding the result.
upward to the next whole dollar. FRLP is designed to direct benefits to those children most in
need and is revised annually to account for changes in the Consumer Price Index (USDA, 2013).

Federal Pell Grant Award eligibility guidelines are the criteria used in identifying
students from households with low SES at the postsecondary level. These income-based
government grants are used to cover an eligible student’s costs associated with postsecondary
education. For the school year 2013-14, the maximum Pell grant award was $5,645 per annum
for students attending any postsecondary institution licensed by the United States Department of
Education. Pell eligibility is determined based upon a formula that calculates a student’s
financial need as determined by the United States Department of Education. Award amounts are
estimated using a standard formula established by Congress to evaluate the financial information
reported on the Free Application for Federal Student Aid. Recipients are awarded all or a portion
of this grant based on the applied formula. It is also used to determine the expected family
contribution (EFC)—the amount that a household is deemed eligible to pay to cover

Included in the Pell eligibility formula are income, household size and number of students within
the applicant’s household currently enrolled in college. Determinants of EFC include “the sum of
(1) a percentage of net income (remaining income after subtracting allowances for basic living
expenses and taxes) and (2) a percentage of net assets (assets remaining after subtracting an asset
protection allowance)” (US Department of Education, 2012a, p.1). Both federal programs, FRLP
and Pell Grants, are commonly used standards of measurement to determine eligibility for
income-based programs and poverty levels for national households.

**Educational equity and efficiency.** Political economy is a term used to describe how
principles of equity and efficiency are negotiated in the structured system of decision making of
the market system (Mankiw, 2009a). In a political economy, government plays a role in markets to bring balance to the relationship between efficiency and equity. Efficiency is an economic term that relates to market equilibrium. In order for a market to reach a state of equilibrium, marginal costs must meet the marginal benefits of production (Mankiw, 2009b). This concept can be applied to goods or services, as is the case with education. Equilibrium also refers to the condition in which the market supply meets the market demand and the price is set. Markets that have equilibrium are efficient. Economists describe efficiency as “the relationship between the average benefits of a situation and the aggregate costs of the situation” (Polinsky, 2011, p 52).

Making adjustments to increase the efficiency of markets is analogous to that of creating a pie. Economists understand their role as individuals who study how best to increase the size of the pie. In education, access is the pie and the market works to determine how best to increase educational opportunity to function efficiently (Okun, 1975). Government intervention is a remedy when efficiency and equity are out of balance. This remedy involves applying tactics to promote equity when markets operate efficiently, yet outcomes are detrimental to the public good. In the example of the higher education market, the government intervenes when prices are misaligned with demands or costs are misaligned with benefits such as educational outcomes. Government officials also intervene to help markets move back toward efficiency, ensuring that society is not negatively impacted by industry decline.

Continuing with the use of this analogy, the definition of equity relates to resource allocation or distribution – the proverbial slicing of the pie. Since efficiency can give rise to inequality, the need exists for political and governmental apparatuses to intervene and ensure that the pie gets divided fairly. This fair intervention can be in the form of government regulations, taxation, laws, or policies. Current trends show increasing government intervention in higher
education markets through regulatory oversight, laws, and policies to ensure efficiency. The goal is to ensure the balance between equity and efficiency by providing consumer protections and requiring more accountability and transparency from institutions of higher education (Conner & Rabovsky, 2011; Dill & Soo, 2004).

**STEM education for economically disadvantaged students.** STEM Education has the ability to address systemic inequalities and market inefficiencies that “result when the social costs of a higher education does not produce the optimal social benefits” (Dill & Soo, 2004, p. 3). There is an ethical issue to be deliberated when considering equity, rights, and optimal social benefits alongside the efficiency of education markets. This need for review is amplified when the system fails to provide equal educational opportunity for students from economically disadvantaged households (Huang, 2013). Unfettered markets could perpetuate intergenerational poverty, especially for the nations impoverished. Okun debates this ideological dichotomy in the “Scope of Rights” where he asks, “How and where does society draw the boundary lines between the domain of rights and that of the marketplace” (Okun, 1975, p 5) The ability of the state to fulfill the rights associated with education have a major economic impact on New York and clear implications for its higher education and STEM job market.

**Influence of early STEM exposure.** Research has shown that early exposure to STEM initiatives and activities positively impacts elementary students’ perceptions and dispositions toward the subject matter (The President's Council of Advisors on Science and Technology, 2010). It is widely documented that by “capturing students’ interests in STEM content at an earlier age, a proactive approach can ensure that students are on track through middle and high school to complete the needed coursework for adequate preparation to enter STEM degree programs at institutions of higher learning” (Dejarnette, 2012, p. 79). Teachers are exploring and
building upon past knowledge that also includes sociocultural approaches to learning science through the use of what is known as reformed-based scientific practices that look at the role of culture and normative identities in relation to students’ affiliation with scientific learning (Carlone, Haun-Frank, & Webb, 2011). In one particular study, Latino and Black female fourth grade students’ perceptions revealed a negative affiliation with science even when they performed and achieved at the same level as their peers from other racial backgrounds (Carlone et al., 2011). Research on innovative reform efforts underscore the need for a more nuanced understanding of how to engage, incentivize, and retain student interest in STEM that goes beyond early exposure to build efficacy and sustainability in curricular and pedagogical practices, especially during the introductory years (Dejarnette, 2012; King, 2012; Smith-Jackson, Evia, Tabor, & Benson, 2012).

**Impact of teacher preparedness.** In addition to curriculum and pedagogy, there exists a body of research focused on the importance of teacher preparedness in STEM. In a cursory review of the literature, the implications for STEM education has both individual and societal ramifications that are directly tied to how effectively curriculum is built and delivered (Carlone et al., 2011; Dejarnette, 2012; King, 2012; The President's Council of Advisors on Science and Technology, 2010). Well-known education activist and reformer, Diane Ravitch, posits that the most effective teachers are those who are innovative and tailor their approaches to the needs of the learner (Ravitch, 2000). This is especially true when working with economically disadvantaged, underserved populations (Anderson-Butcher & Ashton, 2004; Rhodes, Stevens, & Hemmings, 2011; Williams Shanks & Robinson, 2013).

In 2010, the President’s Council of Advisors on Science and Technology wrote a report detailing the current state of science and math education in the United States today. The Council
found that schools often have a small number of “teachers who know how to teach science and mathematics effectively, and who know and love their subject well enough to inspire their students. Teachers lack adequate support, including appropriate professional development as well as interesting and intriguing curricula” (The President's Council of Advisors on Science and Technology, 2010, p. 10). Several researchers and practitioners have affirmed the need for reform to ensure that more innovative means are provided to help capture and maintain student interest in STEM (Jimoyiannis, 2010; The President's Council of Advisors on Science and Technology, 2010; Xiaodong, McInerney, & Frechtling, 2010).

In response to expert opinion and research findings, there has been a scaling up of efforts to develop teachers and build competencies in STEM. The state of Massachusetts responded to the need for STEM professional development at the highest level of state education oversight when Mitchell D. Chester, Ed.D., Commissioner of Elementary and Secondary Education, asserted in his 2010 annual report that professional development efforts of teachers were to be shifted toward content knowledge and conceptual understanding of STEM subject matter as a primary area of focus (Chester, 2011). New York followed suit in 2012 when Education Commissioner, John B. King, Jr., announced a three-year $4.8 million initiative that has been established to focus on STEM professional development for 1,500 teachers in districts with the greatest needs (King, 2012).

**Significance of mentoring and role modeling.** A review of the research has shown that School Based Mentoring (SBM) programs have proven effective in working with economically disadvantaged students (Chan et al., 2013). SBM is the most common approach to mentoring in the United States, serving hundreds of thousands of economically vulnerable students across the country (Chan et al., 2013). The research on the efficacy of mentoring programs in building
academic capacity has been inconsistent in its findings. There have, however, been some successes, notably in a recent longitudinal study of middle school children, which found that strategies using self-regulated learning proved most effective in academic gains for students in math and reading (Núñez, Rosário, Vallejo, & González-Pienda, 2013).

Proponents of mentoring find that it improves the significant potential for promoting improved behavioral, social-emotional, and academic outcomes among youth (Chan et al., 2013). Other positive attributes include relational improvements that stem from involvement in mentoring programs. This type of involvement has also been linked to improvements in self-worth, perceived scholastic competence, and academic achievement. For students in economically disadvantaged households, school based mentoring is a framework that encourages, supports, motivates, and models the resiliency that is needed to succeed in STEM (Chan et al., 2013).

In response to the disproportionately lower number of mentors and role models studying and working in STEM-related fields, more responsive, K-12 innovative initiatives have begun to form using video to connect students to STEM role models (Ware & Stein, 2013). In higher education the focus is on scaling up the number of faculty to serve as mentors and role models to groups underrepresented in the sciences (Griffin, Perez, Holmes, & Mayo, 2010; Strawn & Livelybrooks, 2012).

**Impact of parent involvement.** In 2002, a meta-analysis conducted by scholars at the Southwest Educational Development Laboratory (SEDL) produced several major findings based upon synthesized research from 51 studies over the preceding decade. This study, entitled “A New Wave of Evidence,” provided a comprehensive synopsis about the effects of parent involvement on student learning:
SEDL found that students with involved parents, no matter their income or background, are more likely to earn higher grades and test scores; enroll in higher-level programs; be promoted, pass their classes and earn credits; attend school regularly; have better social skills, show improved behavior and adapt well to school; graduate; and go on to postsecondary education (Henderson & Mapp, 2002, p. 1).

Lack of parent involvement can be detrimental to the educational outcomes of economically disadvantaged students. Issues associated with poverty oftentimes interfere with a caregiver’s ability to be and remain engaged in his or her child’s educational experience. Establishing ways to improve educational outcomes for the economically disadvantaged that support parental engagement is integral. SEDL found one common factor: “Programs and interventions that engage families in supporting their children’s learning at home are linked to higher student achievement” (Henderson & Mapp, 2002, p. 25).

**Wraparound support services.** Students with mental and behavioral issues usually received wraparound support services. These services are now applied more broadly to children in poverty. The wraparound framework is a mechanism that brings the key individuals, mentors, role models, parents, and teachers together to foster success (Eber, 1996). The wraparound approach focuses on coordinating mental health, education, welfare, and other social services into a network to meet the individual needs of children with emotional and behavioral disorders in their home communities. All of this occurs while supporting family members as allies in the treatment process. The process is a tool for building constructive relationships and support networks among youth with their families, teachers, and other caregivers. These services are needed to ensure that an environment is created that is conducive to learning.
Although it was originally designed for students classified as at-risk, or exhibiting many mental and behavioral health issues, the model can also be applied to support economically disadvantaged students who experience some of the factors that negatively impact at-risk students due to the stressors of poverty (Williams Shanks & Robinson, 2013). In the case of economically disadvantaged at-risk students, there is less of a focus on behavioral and emotional health, unless there is an individual need. In the wraparound model, a team works to identify the underlying needs, interests, and limitations of families and service providers, and develop a plan that addresses these interests using natural, community supports wherever possible (Anderson-Butcher & Ashton, 2004; Eber, 1996). A recent study of parent involvement in charter schools found that parents were more involved when wraparound services and other innovative infrastructures that met the practical needs of families were implemented (Smith, Wohlstetter, Kuzin, & Pedro, 2011). Once these hierarchical needs are met, then the attention can shift back to the classroom and the learning that must happen, especially in STEM.

**Effects of school tracking.** In the nation’s secondary school system there is a prevalence of student tracking into academic and career paths that perpetuates a system of poverty (Oakes, 1986; Oakes & Guiton, 1995). Tracking is the practice of dividing students into separate classes for high-average and low-achievers; it lays out different curriculum paths for students headed for college and for those who are bound directly for the workplace (Oakes & Guiton, 1995). Tracking is a prevalent practice in high schools in the United States even while more recent research has found evidence of its negative effect on educational outcomes for students (DeSena & Ansalone, 2009).

Disparate educational outcomes by socioeconomic status and by race at the K-8 level give rise to a disproportionate number of economically disadvantaged and underrepresented
minority high school students tracked toward vocations instead of college. Studies conducted on the negative impact of tracking reveal that school politics played a role in tracking students toward the purpose of ensuring advantage (Oakes & Guiton, 1995). Rigorous high school curriculum is found in classes within the collegiate track designated as college level, Advance Placement (AP) courses. Students who are interested in pursuing STEM careers benefit from meeting the required four years of high school math needed to major in many of the STEM disciplines in college. Economically disadvantaged students are under enrolled and fail to persist in the AP courses that serve as foundational curriculum for the successful completion of STEM degrees (Zarate & Pachon, 2006).

Postsecondary STEM Access and Affordability

**Access and affordability for students with low SES.** Lack of access to quality K-12 and postsecondary education have led to disparities in educational attainment and employment outcomes for low SES students (Carnevale, 2010). The likelihood of gaps in academic achievement increases between individuals from lower SES backgrounds and those from middle and upper income households based upon differences in educational experiences and accumulation of parental assets (Elliott & Friedline, 2013; Kim & Sherraden, 2011). STEM plays an important role in educational equality because of its ability to positively impact households with low SES by providing educational opportunities that lead to increased access to college majors in fields with expanded opportunities for employment after college (Kalevitch et al., 2012; Miller & Kimmel, 2012; Smith-Jackson et al., 2012).

The passing of the Educational Opportunity Act in 1964 generated new programs created to address issues of inequality and unequal access to higher education for poor and underrepresented groups in our nation (US Department of Education, 2012b). Federal programs
such as Upward Bound and Talent Search were created to respond to the need to make college affordable for economically disadvantaged students as part of the broader 1965 Higher Education Act. Coinciding with the struggle for civil rights, access to the nation’s public universities increased. Public colleges and universities offered low tuition rates and the Higher Education Act (HEA) enabled government to fund financial aid and offer loans to offset gaps in the cost of college attendance (Noftsinger Jr. & Newbold Jr., 2007; US Department of Education, 2011).

Even with the creation of legal mandates, disparities in access and ability to attend the nation’s most elite institutions for economically disadvantaged and underrepresented racial minorities still exist today (Reardon et al., 2012). Limiting access for certain groups grants unfit privileges to benefactors of wealth and creates an environment for systemic inequality to flourish unabated (Carnevale & Strohl, 2013; Chang, Sharkness, Hurtado, & Newman, 2014). Research shows that students who have attended elite institutions have higher retention and graduation rates. On average, they are hired into senior level positions, earning higher salaries than their less wealthy peers and attending less selective colleges (Vedder, Denhart, & Robe, 2013). Notably, students who attend and graduate from elite and highly selective institutions considerably outperform and out-earn their peers from other institutions (Needleman, 2008; Paulsen & John, 2002). This disparity has resulted in greater income stratification in society among college graduates.

**Landscape of higher education funding.** As enrollment has risen nationally, there has been a decline in educational appropriations by full-time equivalent students (FTE) by almost thirty percent. FTE students are enrolled in full-time course of study, taking a full-course load per term as defined by the institution and the United States Department of Education. Concurrently the nation has seen an increase in college cost as net tuition revenue rose by FTE,
having doubled since 1987 (State Higher Education Executive Officers Association, 2013). Much media attention has been given to the rise in college costs, the increasing levels of debt incurred by students, and the rising number of student loan defaults (Avery, 2012; Reed & Cheng, 2009; Turner, 2012). The rising inequality in higher education, coupled with increasing student loan debt, provides an opportunity for policymakers to collaborate with scholars, industry, and government leaders to create new models that address equal educational opportunity and outcomes.

Effects of merit aid on student loan debt for economically disadvantaged students. There has been a national shift in how college institutional aid is distributed over the past three decades (Heller & Marin, 2002). One reason for this shift has been the creation of merit scholarships, institutional aid awarded on the basis of exemplary high school averages, SAT scores, and other less identifiable criteria. Merit scholarships are used as a means to financially incentivize middle and upper income students to enroll. The shift to divert aid again has negatively impacted students with low SES and underrepresented minorities (Heller & Marin, 2002; Wang, 2013).

Merit aid directs more funds to less financially needy students instead of being used to fill financial gaps between the amount of government aid received and the net cost of tuition for the most economically disadvantaged students. This redirection prevents low-income students from enrolling or completing college. As a result of this change, low SES students are deferring college due to the expense, opting where possible to attend less selective, open enrollment colleges in an attempt to keep costs down. (Carnevale & Strohl, 2013; Farrell, 2009). Another consequence of redirecting aid includes increased borrowing for college attendance. Two-thirds of students who graduated in 2011 had student loan debt at or in excess of $26,600. In New
York, the average debt total per student was slightly smaller at $25,851 with 60% of student borrowing, slightly down from the national average of 66% (The Institute for College Access and Success, 2012).

As students contend with rising debt loads, there are also a corresponding number of student loan defaults due to growing underemployment and unemployment. This phenomenon is negatively impacting the economy. The student loan default rate has risen for the sixth year in a row from 2006-2012 (Solis, 2004; Thomason, 2013). Research links student loan default with income and employment noting a correlation between earning increases and default declines (Solis, 2004).

**STEM labor market efficiency: demand for science, technology, engineering, and math employees.** Creating a career pipeline in STEM can mitigate the negative impact of under and unemployment of college graduates while boosting the regional economies of the New York State. Scaling up the STEM talent pipeline is critical in order to respond to the projected needs for an expanded labor force (Holman, 2013; Lehman, 2013). There are a broad range of occupations within the STEM fields that require two and four-year degrees by region and by industry (Hagedorn & Purnamasari, 2012; Miller & Kimmel, 2012). There is a need for a new comprehensive model that gets to the core of underemployment among college graduates and income inequality that also addresses labor market constraints.

**STEM career development programs for economically disadvantaged students.** Opportunities exist to address youth unemployment in underrepresented and low-income communities. Rosenbaum refers to this group as the forgotten half who have been failed by the college for all approach (Rosenbaum, 2001). With the primary focus on STEM four-year degrees, many economically disadvantaged students did not see themselves pursuing STEM.
More recent research has highlighted the need for a multi-faceted approach that ignites and inspires economically disadvantaged students to study STEM in a way that also promotes adult and continuing education. Bridge programs should be created between community colleges and universities (Miller & Kimmel, 2012; Strawn & Livelybrooks, 2012).

A review of the research revealed an existing federal STEM career development program for low socioeconomic, pre-collegiate youth in New York, known as the Upward Bound Math and Science (UBMS) program. UBMS paid $35 million dollars to 131 projects around the nation in fiscal year (FY) 2010 (US Department of Education, 2011). Other STEM career programs in New York State include the Science and Technology Entry Program (STEP), the Empire State STEM Learning Network and the STEM Afterschool Mentoring Program, affiliated with the New York Academy of Sciences. STEP is the only program historically and presently funded by the New York State Education Department, which awarded $9.7 million dollars to 50 projects across the state in FY 2010 (NY State Education Department, 2012). There are also programs sponsored by the National Science Foundation and the National Institutes of Health that target youth and college students for STEM preparedness for middle, high school and college level students.

Public-Private Educational Partnerships. The cursory review of the research on effective career development programs reveals that early career preparation increases graduation rates (Wimberly & Noeth, 2005). Creating pathways to employment for the establishment of public private partnerships that promote STEM education and career development of youth is a core element of maintaining a pipeline of future workers. In order to produce a highly qualified work-force, trained in the most innovative approaches, collaboration must happen across entities (Manley, 2012). Curricula must be kept up-to-date and partnership development is important to
that process. Other types of partnerships advance internship opportunities, develop curriculum, provide positions, and create research connections (Díaz Lantada, 2013). These types of partnerships also exist at the state level and typically around such industries as healthcare, education, research, and real estate/mortgages. Vehicles for this synergistic form of collaboration exist within the State of New York’s Regional Development Councils and Centers for Economic Growth. Leading industry trade journals embrace collaboration as necessary for the future of how business and higher education partners (Rifkin, 2013).

**Summary**

The literature review was divided into three areas of research. The bodies of research examined included studies that focused on educational equality, economic efficiency and public-private partnerships. Existing programs and best practices that advance educational equality through STEM were reviewed to identify evidence based outcomes and promising practices for implementation.
Chapter 3
Methodology

Research Purpose

The purpose of this research study was to identify new ways to meet the increasing demands of funding higher education and create pathways to employment that would benefit economically disadvantaged students and regional economies in New York State. The research objective was to develop a comprehensive model at scale that improves outcomes by reducing debt and increasing retention, graduation and employment rates for students majoring in Science, Technology, Engineering and Math (STEM) in New York State. The model incorporates the following four policy factors: 1) public-private partnerships, 2) funding, 3) experiential learning and 4) post-graduation employment.

To achieve the intended research goals and objectives, this study was developed from an interpretative framework of pragmatism, which focuses on developing concrete outcomes from the research (Creswell, 2013). Because of the complexity and multi-dimensional nature of this research, a variety of qualitative methods and theoretical frameworks were drawn upon, including aspects of phenomenology, grounded theory and critical theory. Utilizing components from a variety of methods and perspectives was conducive to building a practical proposed model to address a particular problem of practice.

The theoretical foundation of the study was grounded in a framework of critical theory. Critical theory was developed in Germany in the 1930s. The advent of the theory is attributed to Max Horkheimer in response to social conditions and politics during World War I (Cambridge University, 2004). It is defined as “not merely descriptive, but also a way to instigate social change by providing knowledge of the forces of social inequality that can, in turn, inform political action aimed at emancipation (or at least at diminishing domination and inequality)”
This information can be received in a valuable fashion (Cambridge University, 2004). This is evidenced in the literature review, which provides historical and current overviews that detail multiple aspects of educational inequality (Carnevale, 2010; DeSena & Ansalone, 2009; Huang, 2013; Noftsinger, Jr. & Newbold, Jr., 2007).

This study also connects broader social issues to a pragmatic approach of problem solving for systemic injustice by developing a model intended to address issues of educational inequality in higher education and labor market inefficiency. To accomplish this, aspects of a phenomenological approach were drawn upon to explore the perceptions based on the experiences of the participants being interviewed (Moustakas, 1994). The participants in this study were experts and employees of educational organizations, corporations, nonprofits and state government. Participants were asked questions (see Appendix A) that would assist in better understanding the phenomena that impact how economically disadvantaged students are funded, retained, graduated and employed in New York or surrounding states.

Elements of grounded theory were used as the framework for data analysis in coding. Used within this context, grounded theory refers to an inductive method of analysis that can lead to an understanding of the patterns and theories of behavior (Patten, 2012). Using aspects of grounded theory as an approach to data analysis enables the researcher to “unravel the elements of experience” (Moustakas, 1994, p. 4). Interviews were analyzed using an inductive method, starting with open coding to identify themes that surfaced from a review of the transcripts and post-interview memos (Patten, 2012). Patterns found within the perceptions of the interviewees and the behaviors of educational leaders within organizations charged with serving economically disadvantaged students were analyzed. By drawing on a number of approaches, this study connects the qualitative descriptive components of phenomenology and grounded theory using a
pragmatic framework. These combined methods evoke a deeper understanding of the perceptions, behaviors and experiences of the participants in cross-sector collaborative situations.

**Research Design**

The development of this model was based on qualitative research methods which included completing a document review, attending a conference and workshop, conducting web analysis and semi-structured interviews (Neuman, 2003). The document review and web content review included a collection and analysis of existing STEM education public policies, STEM programs at the K-12 and higher education level, undergraduate student funding resources, and public-private partnerships that support students with low SES and underrepresented minorities focusing on STEM fields. In order to understand the process, best practices and strategies for development and implementation of a new large-scale comprehensive model, an analysis of existing federal and state programs that target youth and college students in STEM was conducted.

The document review also involved researching existing statewide cooperative programs in K-12 schools, higher education, career development programs, state loan forgiveness programs, private scholarships, and grant programs funded by foundations that support innovative education initiatives. The analysis of policies and programs occurred at the federal, state and local levels of government. A sampling of these programs include the Harlem Children’s Zone, Project Strive Together, MassInsight, the Collegiate Science and Technology Entry Program, the Educational Opportunity Program, the North Dakota STEM Loan Forgiveness Program, New York State Education Department Physician Loan Forgiveness Programs, and the Georgetown University Center on Education the Workforce. A range of other
programs were also studied to help gain insights into access and affordability for economically disadvantaged STEM students.

The research design also included data collected from conferences and workshops. These forums consisted of workshops on STEM regional economic development and local human capital needs of industry employers. Community workshops focused on STEM access and diversity for economically disadvantaged youth. Government-sponsored workshops included discussions on developing policies that advance educational equality for underrepresented groups in STEM fields. Regional economic development conferences focused on the creation of a skilled labor force to fill existing and future STEM vacancies throughout New York.

**Research Questions**

Three central research questions guided this study and allowed interviewees to describe their own approaches towards comprehensive evidence-based solutions to educational inequality in STEM. These identified programs planned to demonstrate successful outcomes or displayed promising results in serving economically disadvantaged and underrepresented minority students. The research questions also reflect the intention to explore existing and potential public-private partnerships that use STEM as an approach to grow regional economies through workforce development by establishing career pathways. To accomplish these goals, questions were drafted based on key categories including funding, student curricular and co-curricular programs, experiential education and career pathways. Participants were selected because of their expertise and current role within these respective areas. Responses were analyzed to determine congruency between the literature and interviews as well as to identify innovative programs in the pipeline. The research questions are as follows:
1. What public-private funding programs can be developed to reduce costs and debt associated with college attendance for Pell-eligible STEM students in New York State?

2. What policies and best practices can be developed from existing curricular and co-curricular programs to prepare students academically and professionally for postgraduate careers?

3. What comprehensive public-private partnerships can be created or expanded to establish a large-scale career pipeline for STEM graduates in New York State?

Participants

Purposive criterion sampling was used to determine who would be interviewed based on the participant’s knowledge of the criteria (Patten, 2012). A summary description of the 11 interviewees is as follows:

Participants 1 - Community College President/Interview 1
Participant 2 - A principal of a technical high school in New York State/Interview 2
Participant 3 - Private College President/Interview 3
Participant 4 - A higher education lobbyist who advocates on behalf of New York State and New York City/Interview 4
Participant 5 - Public University President/Interview 5
Participants 6 - Senior official in statewide education leadership /Interview 6
Participant 7 - Senior official in statewide education leadership/Interview 7
Participant 8 - One Fortune 100 Corporate Foundation Director/Interview 8
Participant 9 - One Teacher/Interview 9
Participant 10 - One Fortune 500 Senior Vice President/Interview 10
Participant 11 - A nonprofit executive leading in regional economic development efforts in New York State/Interview 11

These eleven participants were selected because they bring expertise in one or more of the topics of study, including STEM policy, STEM programs, K-12 STEM education, or strategic industry-higher education partnerships at state and national levels. The researcher relied on an existing professional network to request referrals to gain access to the individuals interviewed.

Data Analysis

Rev.com, a professional online transcription service, transcribed the interviews. Dedoose, a qualitative research-based software, was used to code the data collected from the 11 interviewees. The software was also used to code and analyze information from the document review and interviews. Post-interview memos were also coded and analyzed to identify common experiences or initial observations. The next phase of analysis included axial coding used to identify themes and relationships between the data (Patten, 2012). A valuation of the themes and data followed, ending with contextualizing themes to analyze and understand phenomena. The analysis produced a set of findings that responded to the research questions.

Summary

Chapter three described the methodological approach, framework and theory used as a foundation for this research study. The focus of the interviews and document reviews was to identify best practices, promising innovations and policies that advance collaboration and partnership in STEM education and employment. The following chapters will build upon that
foundation to explore results, findings and provide recommendations for future researchers and practitioners.
Chapter 4

Results

Overview

The goal of this study was to develop new approaches to funding, graduating, and employing economically disadvantaged students in New York State who are pursuing Science, Technology, Engineering and Math (STEM) careers. The purpose was to create a comprehensive model with collective impact that improves educational and employment outcomes. Through semi-structured interviews, document reviews and web research, this study revealed the existence of programs that demonstrate positive outcomes. Based on these outcomes, best practices were identified to inform model development. This study also highlighted gaps in policy, programs, and practices that provided an opportunity for the development of recommendations for a model that addresses identified disparities.

The theoretical frameworks that guided this study were based on an interpretive framework of pragmatism, with a focus on establishing concrete outcomes to inform model development (Creswell, 2013). Critical theory served as a tool to help explore the role of institutionalized oppression on educational equity (Cambridge University, 2004). Critical theory provides a framework to help examine the political, social, and cultural context of education. There are shared assumptions that intersect with other critical social theories that shaped this study’s results, including the following tenets:

1) raising consciousness about present exploitation is a priority; 2) demonstrating the opportunity for a better future free from all kinds of alienation is possible; and 3) achieving liberation and freedom is essential in order to understand the dialectical relationship between structure and human agency, since knowledge of structure can help
people change social conditions (Hargreaves, Fernandes, & Dinanthompson, 2003, p. 182).

This study raises consciousness about how system issues impact educational outcomes for socioeconomically disenfranchised individuals with the goal of developing solutions to improve their quality of life. Evidence of these assumptions was embedded in the study participants’ responses. This study also revealed individual and systemic barriers. These are barriers that perpetuate achievement gaps in STEM education and careers for economically disadvantaged students. An example of systemic class-based policies was found in a report produced by the Schott Foundation. The report included an examination of red-lining policies that occur in New York City and perpetuate educational inequalities based on geography (neighborhood) and race (Schott Foundation, 2012).

Interview participants were selected for this study because of their knowledge of policies that impact education, government and industry, as well as for their collaborative roles in public-private partnerships. In addition to interview sessions, community forums, STEM pipeline workshops and workforce development conferences were attended to gather a range of insights and perspectives. At these events, an array of constituents were represented, including direct school service providers, teachers, parents, leaders of K-16 education, and other key stakeholders in the state of New York.

Through the perspectives of these stakeholders, this study explored the problem of underrepresentation of economically disadvantaged students in STEM education and career pipelines. The results revealed that social issues associated with poverty and systemic issues within complex educational bureaucracies were barriers to STEM access and opportunity. These barriers were shown to negatively impact the three areas of focus within this study: 1) college
funding, 2) secondary and postsecondary completion, and 3) employment for economically
disadvantaged students in New York. Evidence associated with the results based on each
respective research question is categorized under policies, programs, and partnerships in the
following section.

Research Question 1: What public-private funding programs can be developed to reduce
costs and debt associated with college attendance for Pell-eligible STEM students in New
York State?

The impact of policies on funding programs. A major result of the study was that a
college affordability gap can provide an opportunity for policymakers to leverage existing
program structures to create new policies that increase access for STEM students with low SES
(Conner & Rabovsky, 2011; White House Press Secretary, 2013). This study concluded that
expanding or restructuring new and existing grant and loan programs was key to improving
retention for low SES students and resulting in less debt after graduation. These programs need
to be ones that provide a no-cost or low-cost college education to high-achieving students with
low income in order to positively impact access. A positive outcome of increased access is
greater student enrollment in New York’s colleges and universities. Supporting student
accessibility to attending IHEs mitigates market inefficiencies in higher education.

This study identified the need for additional public funding of education for economically
disadvantaged students. In a review of policy, legislation, and interview data, a major result was
that New York’s Tuition Assistance Program (TAP), an income-based program for economically
disadvantaged students who attend college in the state, had not received an increase in over 14
years. Participant 3 stated, “Financial aid should be used as a vehicle to minimize student debt”
(Interview 3). Participant 7 mentioned that increases in federal Pell grant awards should have
signaled to the state, a need to increase TAP awards for New York’s residents with low income (Interview 7).

Governor Andrew Cuomo announced a one billion dollar infusion into the state budget to cover costs for a $165 per student increase in TAP for the 2014-15 academic year. The New York State legislature proposed a $300 per student increase in the budget process. Budget negotiations saw a decline in the dollar value of the per pupil award. The highest amount awarded in TAP was $5,000. With the increase, TAP awards now rise to $5,165 per student. Participant 7 stated, “There was a time when full tuition at a state or city university could be covered by a Pell and TAP award. That is no longer the case” (Interview 7). As college costs continue to rise, access for many means assuming student loan debt to offset need-based financial aid. Research reveals that cost is a barrier to both college attendance and persistence (Elliott & Friedline, 2013; Paulsen & John, 2002). The state should continue to implement funding policy changes that promote access, but there is a growing need for policies that hold institutions accountable for tuition increases. Issues associated with affordability also need to be addressed.

The document review revealed that state governments are exploring and adopting innovative college funding policies that ameliorate the impact of student loan debt similar to the Pay It Forward (PIF) model. The 113th Congress directed the Secretary of Education to conduct a feasibility study of the PIF program to determine its usability as a model that addresses college affordability. The bill describes the PIF model as a system in which the Secretary, a state, or an institution of higher education (IHE) places the student’s need to borrow as a qualifying characteristic under the William D. Ford Federal Direct Loan program. All or part of the student cost of attending an IHE is covered in exchange for the student’s agreement to contribute a
certain percentage (not to exceed 5%) of their annual income for a specified number of years (not
to exceed 25 years) after graduating or ceasing to be enrolled at the IHE (Pay it Forward
Affordability Act, 2014).

The PIF approach ensures that students receive a free education and pay a percentage of
their income back into the system to subsidize costs for future enrollees. Congress has authorized
competitive matching grants to states to establish and carry out PIF pilot programs. The PIF
model has built-in criteria that give preferences to IHEs that reduce or keep the costs of
attendance down. This reward versus regulation policy is an opportunity to incentivize IHEs to
make college more affordable for students with low SES. Oregon and Michigan have PIF
programs in different phases of adaptation.

PIF policies have received both praise and criticism. The policies have been lauded for
their innovation. However, critics point out the adverse selection structure of PIF programs that
will allow higher-income students to be negatively and disproportionately impacted, paying more
of a percentage of their income; PIF is viewed by some as a financial disincentive for success. To
mitigate this imbalance, the Hamilton Project out of the Brookings Institute proposes what it
describes as “a single, simple, income-based repayment system called Loans for Educational
Opportunity (LEO), to replace the current, bewildering array of repayment options” (Dynarski &
Kreisman, 2013, p. 1). LEO is structured to allow students’ loan payments to increase and
decrease with a borrower’s earnings, just as contributions to Social Security fluctuate. Students
who use LEO must provide a fraction of their earnings for each paycheck, with a larger portion
given when incomes are high and a smaller fraction when earnings are low (Dynarski &
Kreisman, 2013).
Programs. This study revealed that the New York State STEM Incentive Program or NYS STEM Initiative is a program with the potential to offer opportunities for economically disadvantaged students to attend college. The NYS STEM Initiative is a recent program proposed by Governor Cuomo in the 2014 State of the State Address. It is scheduled to launch in the 2014-15 school year. The initiative is also known as the Top Ten Percent program. As part of this initiative, students in the top 10% of their class in New York’s high schools will receive a free State University of New York (SUNY) or City University of New York (CUNY) education. Qualified students must major in STEM and graduate from a two or four-year SUNY or CUNY institution with a 2.5 grade point average or higher. Students must also sign a contractual agreement indicating that after graduation they agree to work in a STEM job in New York for five years (Governor’s Press Office, 2014).

The NYS STEM Incentive Program is modeled similarly to initiatives in other states that provide scholarships or loan forgiveness to students who major and work in STEM for a committed time after graduation. New York’s program is unique in that it promises a free public education to the top 10% in comparison to the other programs researched in this study. Additional programs reviewed were found to offer scholarship amounts that defray costs of attendance at any institution for qualified applicants in the states’ public or private IHEs.

Participants in this study described the NYS STEM Initiative as a program with promising outcomes, but there were concerns expressed about the political will to structure the program in a way that will allow economically disadvantaged students to benefit. As Participant 5 stated in Interview 5: “My main point is that we need to leverage off of opportunities like the Top Ten Percent program that the governor talked about and find ways to work more effectively together” (Interview 5). Participant 11 echoed these concerns about funding programs for
economically disadvantaged students: “If you could demonstrate…whatever universe you’re talking about… get the cream of the crop and then you can find funding for them to get through [school]” (Interview 11).

These concerns affirmed research that demonstrates that students who come from households with low SES are at a disadvantage when they compete with students from better-resourced schools and higher-income households for merit funds (Heller & Marin, 2002). Participants revealed that ensuring opportunities are extended to the state’s poorest students is an important element of education funding policy development.

*STEM loan forgiveness and Pay It Forward programs.* States differ in the approach to student financing of higher education. Programs that focus on incoming undergraduate students such as NYS STEM Initiative Program are structured to fund students retroactively through traditional loan forgiveness programs and newer PIF programs. Retroactive policies include those implemented by North Dakota’s STEM Occupations Student Loan Forgiveness Program. This program allows students to earn up to $6,000 maximum award toward loan repayment if they remain in North Dakota and work in a STEM-related field. North Dakota’s program is intended to reduce student loan indebtedness for college graduates who work in STEM-related fields in manufacturing (North Dakota University System, 2013).

The Choose Ohio First Program, sponsored by Ohio’s Department of Education, is funded through public-private partnerships between government, industry, and education. Choose Ohio First scholarships have been awarded to more than 4,000 students in 28 programs involving 41 public and private institutions. Scholarship awards range from $1,500 to $5,200 per student, per academic year. The scholarships have leveraged more than $32 million in matching
funds from Ohio’s colleges, universities, and business partners (Ohio Department of Higher Education, 2013).

**Partnerships.** Collaborative partnerships yield innovative approaches to educational equality and are built upon pipeline models. This study identified pipeline approaches as effective methods of advancing STEM outcomes at secondary and postsecondary levels. Prevalent in the results were two coordinated education designs classified as P-16 and Cradle to Career. Such program types are described as partnership interventions; they are designed to focus on the development of new relationships among organizations (Lawson, 2013). The P-16 framework centers on education, emphasizing college completion that has been fostered by connecting systems of schooling for traditional-aged learners with a College for All approach.

The Cradle to Career design differs in that it focuses on developing educational systems and targets learners of all ages who join the system at multiple points of entry. Learners could include adults, career changers, and others perceived as non-traditional students (Lawson, 2013). Components of both approaches reach beyond academics to incorporate social infrastructures of support that are seen as vital in establishing positive outcomes when serving economically disadvantaged students (Anderson-Butcher & Ashton, 2004; Eber, 1996; Smith-Jackson, Evia, Tabor, & Benson, 2012).

This study revealed that cross-sector partnership interventions provide a model of coordination of efforts for maximum impact in advancing STEM education and employment goals for economically disadvantaged students. Because these programs are funded through public-private partnerships, they provide an existing infrastructure that can be tailored for STEM. Results from this research report focus on two Cradle to Career and P-16 pipeline initiatives targeting economically disadvantaged students.
The first program, the Strive Together Cradle to Career Network, was founded in 2006 by Dr. Nancy Zimpher, former president of the University of Cincinnati and current SUNY chancellor; Michael Graham, SJ, president of Xavier University; and James Votruba, president of Northern Kentucky University along with the superintendents of the Cincinnati, Ohio, Covington and Newport, Kentucky school districts.

Strive brings individuals together from across sectors that include education, industry, private foundations and the community, to work toward the establishment of coordinated efforts that improve student achievement. Strive, like most Cradle to Career initiatives, builds a roadmap from kindergarten readiness to postsecondary completion. Strive has four benchmarks which include having a shared community vision, evidence-based decision making, collaborative action and investment and decision-making. Since its founding, the initiative has brought together leaders from industry and regional community-based organizations.

Another partnership intervention program with demonstrated evidence of positive outcomes is the Harlem Children’s Zone (HCZ). HCZ serves one of New York City’s most historically impoverished neighborhoods. The program has a pipeline approach to education that begins at the earliest stages of life and development. HCZ supports students through college completion. Former Chief Operating Officer and newly-appointed President–Chief Operating Officer Anne Williams-Isom posits, “Only a comprehensive approach can meet all the challenges our kids face” (Druckenmiller, 2013, p. 4).

HCZ is based on five core principles that leverage partnerships in support of serving economically disadvantaged students. These principles include “serve an entire neighborhood at scale; create a birth-through-college pipeline of best-practice programs; build community among
parents, children, and institutions; rigorously evaluate programs for continuous improvement; and cultivate a culture of success within the organization” (Druckenmiller, 2013, p. 1).

HCZ’s principles align with a P-16 framework that centers on education and emphasizes college completion by focusing on “connecting systems of schooling” (Lawson, 2013, p. 653). HCZ’s model has received national recognition for its evidence-based approach to integrating social supports. This approach involves partnering with family and community members as well as health and wellness professionals for a holistic approach to educating economically disadvantaged students. Each program goes beyond academics to incorporate social infrastructures of support. Research shows that these types of case management and wraparound services have positive outcomes when working with economically disadvantaged students (Anderson-Butcher & Ashton, 2004; Eber, 1996).

Because Cradle to Career initiatives are assessment driven, comprehensive programs with collective impact, they provide a model for cross-sector partnership investment. The study’s results revealed a willingness of government and industry to fund comprehensive models of scale that can serve a broad base of students for maximum impact. Participants in this research study identified various programs that were considered effective partnership models—those that delivered positive or promising outcomes in the academic and career preparation of economically disadvantaged STEM students.

Another major result of this research study was that existing pipeline programs can serve as a means of providing an infrastructure that can be tailored to serve economically disadvantaged STEM students. Creating and funding STEM Cradle to Career pipelines in New York through public-private partnerships will build college readiness and provide a social
network of support to Pell recipients that will increase retention and completion rates (Chang, Sharkness, Hurtado, & Newman, 2014; Chen & Soldner, 2013; Kalevitch et al., 2012).

This study identified STEM Pipeline partnerships in New York that are currently being established. These partnerships show promising practices and early evidence of positive outcomes. These existing partnerships are not explicitly modeled after Cradle to Career or P-16 programs. Instead, partnership-based initiatives are structured to connect populations within the pipeline by bridging middle school to secondary and postsecondary education. An example includes the NYS Pathways in Technology Early College High School (P-TECH) partnerships, a career and technical education model.

P-TECH is an initiative that was piloted in Brooklyn, New York. It received national recognition for the innovative grades 9-14 approach to funding STEM education. When P-TECH began in 2011, it was built upon a model of collaboration among the New York City Department of Education, CUNY, New York City College of Technology, and the IBM Corporation (Center for Children and Technology, 2011).

Partnerships have expanded and now consist of STEM industry corporations such as IBM, General Electric, Global Foundries, and other corporations located throughout the state that work collaboratively with school districts and IHEs. The primary objective of partnering is to develop a pipeline from the start of high school (ninth grade) to postsecondary education at the associate’s degree level, continuing on through to employment at the partner organizations. The program has been described by Participant 6 as a “notable innovation where there are attempts to build a strategic evidence-based approach” to accessing STEM career pathway programs at the pre-collegiate level.
P-TECH was identified by participants in this study as a promising model that could be retrofitted to have a positive impact on STEM education for students with low SES. While it does not explicitly target students with low income, P-TECH draws students from diverse neighborhoods throughout New York City. Some programs are housed in buildings that are considered Turnaround Schools or schools identified by the federal government’s Department of Education as low performing. P-TECH is structured in ways that mitigate educational inequalities through its creation of a school culture focused on building capacity for STEM careers. The model positions students for employment while bringing sustainable innovations that address higher education and labor market inefficiencies through its collaborative pipeline approach. As a result of system-wide use of this type of model, higher education will enroll students who are better prepared. The labor market benefits by P-TECH’s positive impact on workforce development that addresses STEM vacancies.

P-TECH uses a first-in-line standard for hiring which is contingent upon successful program completion. This standard increases the likelihood of participants achieving a position within a partnering organization. The career model allows “students to participate in an ongoing, sequenced workplace learning curriculum informed by current and future industry standards that includes career goals, mentoring, guest speakers, workplace visits, and internships. Minimum requirements for entry-level IT jobs, as provided by IBM and other industry partners, have been mapped to the curriculum and are serving as academic benchmarks and targets” (Center for Children and Technology, 2011, p. 7). The first cohort is scheduled to complete the program in 2017.

The state’s support brings to scale what started as a smaller pilot in New York City. That pilot has now been expanded to sixteen partnerships represented in each of the 10 REDCs.
throughout the state. P-TECH’s early indicators of success in years one and two resulted in New York’s Governor Cuomo launching a statewide competition as part of the 2013-2014 Executive Budget. Sixteen partnerships were selected to receive four million dollars in funds for partnerships between school districts, universities, and corporations located within the 10 regions of the REDC (Hughes, 2013).

The funding partnership provides full scholarships towards the completion of associate’s degrees. The benefit associated with this model is that it allows students to elect to pursue employment upon program completion or pursue a baccalaureate degree in a more cost-effective manner that lessens debt and time to degree. This structured approach to college and career partnership programs—providing individualized student educational funding—is one approach to education financing for economically disadvantaged students interested in STEM careers.

P-TECH is funded through collaborative partnerships and receives funding from various organizational types. For the sixteen newly approved initiatives, there is a first-year, four million dollars infusion of state support. Schools connected with this initiative and defined as in need of improvement were eligible for additional School Improvement Grants from the federal government. The P-TECH report provides a series of recommendations for schools interested in implementing its model. Some of these suggestions include seeking grants from private foundations and partnering affiliates, as well as hiring a grant writer to assist in securing funding.

**Research Question 1: Results Summary**

This study revealed that New York is piloting initiatives throughout the state that can be expanded and scaled for collective impact to serve economically disadvantaged students. Research shows that there has been minimal progress made in closing the funding gap for economically disadvantaged students as evidenced by a fourteen year gap between state aid
increases that resulted in a small increase of $165 per year, per student. There has been more progress made in the development of programs to fund STEM students in the state, but these programs are merit-based and fail to address the college affordability gaps based on socioeconomic status.

Additional gaps were identified that indicated a need for public-private partnerships to be broadened, inviting private foundations, independent postsecondary institutions and additional industry participants that reflect the STEM diversity in each region of the state. Partnership expansion is necessary to scale up for maximum capacity in serving economically disadvantaged students who attend low-performing schools. Strategies to ensure college funding for high-achieving economically disadvantaged students who are not among the state’s top 10% should be taken into consideration to ensure success.

**Research Question 2: What policies and best practices can be developed from existing curricular and co-curricular programs to prepare students academically and professionally for postgraduate careers in STEM?**

**Overview of the challenges.** Multiple barriers that negatively impact efforts to close the achievement gap and better prepare STEM students to achieve academically and professionally were identified in this research study, and throughout the literature. Research shows that economically disadvantaged students, underrepresented minorities and males from households with low income, are less likely to persist in STEM majors in college and are less likely to graduate (Chang, Sharkness, Hurtado, & Newman, 2014; Chen & Soldner, 2013).

National data reports that a total of 48% of students with bachelor’s degrees and 69% of students with associate’s degrees who entered STEM fields between 2003 and 2009 had left these fields by spring 2009 (Chen & Soldner, 2013). Of this total, the report finds that STEM entrants with bachelor’s degrees who were male or who came from low-income backgrounds had
a higher probability of leaving STEM by dropping out of college than their peers who were female or came from high-income backgrounds (Chen & Soldner, 2013). The following section presents results that emerged from this research study relating to barriers faced by economically disadvantaged students studying STEM. The section concludes by reporting results that pertain to policies, practices and partnerships in academic and career preparation.

**Barriers to achievement.** This study identified several themes that illuminated barriers to STEM academic achievement and ways in which collaborative partnerships can be developed to improve outcomes for students with low SES. Study participants reported that negative perceptions, lack of STEM awareness and self-concept issues were impediments to achievement in STEM education. A shared theme, supported by document and literature reviews, was the “STEM is not for me” perspective. The problem was framed by Participant 2:

> When it comes to science, technology, and math, we have so many of our [low SES and minority] children that don't believe it's the area for them, so they don’t pursue it. We have people who are in guidance and teachers who don’t push our kids. We have parents that are not thinking about pushing their children in these areas and having high expectations of achievement for their children. That’s for someone else [they say]. This keeps happening, especially as we go through this science, technology, engineering, and math revolution. When we talk about Nanoscience, they [students and parents] think it sounds so vague and they don’t understand it, and they don’t understand where they fit in (Participant 2/Interview 2).

Evidence supporting the need for more fundamental academic support, higher expectations of student achievement from parents and teachers and efforts that build up the
confidence of students to study STEM were expressed by Participant 2/Interview 2. These attitudes and perceptions were exemplified in the comments from attendees at a 2014 forum on STEM education for students of color with low SES in K-12 schools. The New York Chapter of 100 Black Men of America Inc., a national organization, hosted the forum. In attendance were politicians, community college leaders, school district leadership, prominent black leaders in STEM, and black engineering students. The event drew over 70 community residents, stakeholders from local institutions, and parents. Representatives of the community expressed a lack of awareness about STEM subjects and majors. Attendees expressed a desire that more labor market information be shared with their students about STEM jobs that did not require a baccalaureate degree in addition to information about STEM majors and careers that require advanced degrees.

Many attendees articulated non-academic concerns about poverty issues impacting their communities—factors that impede a student’s ability to study complex subjects. Comments made at the forum aligned with those of the interviewees, showing congruency in the need to address negative self-perceptions. Participant 2 stated, “And then, when it comes to science, technology and math, we have so many of our children that… don’t believe it’s the area for them, so they don’t pursue it…” (Interview 2). The attendees also outlined barriers to STEM engagement including mistrust of community outsiders, problems found within the schools, violence within the community, and a lack of parental oversight and involvement in some households.

The problems identified at the community forum are not new. Similar concerns were identified in a 1984 report by the New York State Regents on action items to be taken to address the underrepresentation of students of color in STEM fields. The Regents report from thirty years
ago captures existing community concerns articulated in the 2014 community session. An overview of select criteria from a 2013 study by Perkins gives a summary of the concerns of the Regents. These points were reinforced at the 2014 forum and evidence found in the document review. The recommendations of the Regents that align with the results of this study focus on the following:

Career: Limited awareness of professional career options among minority students; Self-Concept: Lack of aspiration resulting from limited awareness, inadequate counseling, language difficulties and self-image problems and low expectations of minority students, conjoining to poor self-image, lower aspirations, and lower achievement levels; Social Capital: Inadequate counseling at stages of education when critical decisions are made and Policy Implementation: Inflexible or insensitive admissions procedures and professional programs (Perkins, 2013, p. 62).

The results show that the thirty years that have ensued from the time of the report until the time of this research indicate a lack of progress on the issues that have been identified as barriers to educational success for economically disadvantaged and underrepresented students in STEM.

**Policies.** This research study revealed the need for policies that respond to barriers and achievement gaps. Study results can be divided into three areas of prominence: (1) Readiness or the need to address teacher preparedness and professional development so that teachers are “Ready to Teach;” (2) student preparedness through enhanced support services so that students are “Ready to Learn”; and (3) the need to dismantle institutional bureaucracies that impede the ability for stakeholders to be “Ready to Partner.”
**Teacher preparedness.** At the core of the promotion of STEM education, there exists an increasing call for better teacher preparedness to meet national, state, and local educational goals. In addition to a need for additional recruitment of competent STEM educators, access to content-specific professional development for STEM teachers is crucial. The necessity of addressing this subject matter knowledge gap was found in the research results. For example, the report of the President’s Council of Advisors on Science and Technology portrays the current challenges associated with science and math teachers “who know how to teach science and mathematics effectively, and who know and love their subject well enough to inspire their students. Teachers lack adequate support, including appropriate professional development as well as interesting and intriguing curricula” (The President’s Council of Advisors on Science and Technology, 2010, p. 2). To respond to this labor market and expertise gap, those who award federal and state funding have focused on shifting resources to develop grants that support STEM teacher recruitment and professional development.

Participant 1 cited a need to require subject mastery of elementary school teachers in order to better prepare them to teach STEM subjects:

There are times that elementary teachers who are not strong, will not spend a lot of time in science and math and do the bare minimum to say, “I satisfy the curriculum for teaching, but I really didn’t do due diligence in really engaging the students in learning the material and finding innovative exciting exercises that can assist in teaching the material… getting the young men and women to really show some signs of excitement and engagement that they are embracing and responding to STEM knowledge.” (Interview 1).
Participant 7 discussed the need for more professional development in STEM for both teachers and faculty by stating, “To promote innovative curricular partnerships it is important to address the professional development needs of both faculty and teachers” (Interview 7).

In 2012, New York State Education Commissioner John B. King, Jr. announced a three-year, $4.8 million initiative with the College Board to provide professional development training in advanced STEM coursework for teachers throughout the state. The initiative started in 2012 and was set to continue through 2014. The STEM training is being funded through the Race to the Top (RTTT) program, a national competition that involves the following:

States…are leading the way with ambitious yet achievable plans for implementing coherent, compelling, and comprehensive education reform. New York’s teacher professional development program was created to develop and deliver direct and on-line professional development to 1500 teachers in high-needs districts throughout the state (King, 2012, p. 1).

K-12 student preparedness: policies that impact academic student preparedness. The New York State P-12 Common Core Learning Standards (Common Core) is a set of standards developed by educators and leaders from forty-eight states. Policymakers and government leaders adopted these standards as part of the national RTTT Initiative. New York’s 2012 switch to the Common Core has increased standards in STEM education. Broadly defined, the standards are nationally-shared learning goals that are currently being implemented in forty-five states. The Common Core was adopted in New York to provide a more rigorous curriculum, increase academic preparedness, and improve college readiness.

Interview participants aligned with the research supporting the need for statewide policies that support STEM learning and achievement, like the Common Core Learning Standards.
During the interviews, participants highlighted a prioritization of efforts at the secondary level by district, local, and statewide entities that include policy proposals and implementation plans that require four years of secondary math for all students. There was also a focus on improving standardized test scores, offering more rigorous regents exam preparation, increasing the number of students taking Advanced Placement courses, and other policies that serve to improve high school graduation rates in economically depressed communities (Hallett & Venegas, 2011; Schott Foundation, 2012; University, 1996; Zarate & Pachon, 2006).

Policies that impact non-academic student preparedness. The study’s results present the need for the expansion and better integration of policies that establish infrastructures of social supports and wraparound services that will benefit K-12 students both inside and outside of school. An examination of the research revealed that institutions are relying on volunteer corps such as Citi Year and Peacemakers—affiliates of AmeriCorps, the Corporation for National and Community Service—to provide in- and out-of-class support to students. There are also pipeline programs and a number of community colleges that are structuring case management services to support student learning.

Postsecondary student preparedness. Participants also discussed the need for articulation agreements and 2+2 or 2+3 (measured in terms of years to completion) programs between community colleges and four-year institutions and universities to ensure an on-time four-year or five-year completion time. Some policies and practices in higher education result in students who have had a difficult time transferring credits across institutions. In some instances, students were losing credits that did not transfer, increasing time to degree completion due to complex institutional degree requirements and course acceptance policies. Policy changes at the secondary and postsecondary levels that improve time to degree completion and coordinate seamless
transfer of credits will have a positive effect on getting economically disadvantaged students to enter the workforce sooner.

**Partner preparedness.** The need for effective partnerships has been well established in the research (Bailey, et al., & Los Angeles City Schools, 1963; Xiaodong, McInerney, & Frechtling, 2010). State funding reductions, economic recession, increasing poverty, underemployment and unemployment, as well as anticipated job growth in STEM, offer a few reasons why organizations have come to the realization that they must work across silos to problem solve and partner to improve educational outcomes. Participants in this research study provided a range of examples that demonstrate specific barriers to productive collaboration:

“Get everyone to the table at the beginning to develop the program” (Participant 5/Interview 5).

“Convene key players, share best practices, get data and decide how all stakeholders can play a role” (Participant 2/Interview 2).

“There needs to be more coordination; everybody has their own little program and most of these are not highly coordinated” (Participant 1/Interview 1).

“We (industry) will develop innovative models that we cannot implement because either the organization does not have the capacity to implement or it is not a priority for the organization, so it’s hard to get buy-in” (Participant 9/Interview 9).

“Too much time is spent in meetings, planning, and brainstorming. Don’t invite industry to the table until you’ve developed the program and then be prepared to make specific requests based upon your organization’s needs” (Participant 8/Interview 8).

“One of the policy impediments is that people don’t know how to make policy around complex issues, but we need a complex intervention” (Participant 7/Interview 7).
“Schools are not organized to partner easily with business and industry and business and industry is not organized to easily partner with K-12 (schools). The same schism exists between K-12 and higher education” (Participant 7/Interview 7).

“Initiatives must be developed that are advantageous to all partnering organizations” (Participant 6/Interview 6).

“Policy constraints serve as barriers to collaboration” (Participant 3/Interview 3).

These responses demonstrate that a framework built upon policies and practices that address complex systems change is needed to develop and scale a statewide response to improving STEM education and career outcomes for students with low SES. Lawson (2103), a complex systems expert, describes the importance of partnerships, well-developed infrastructure, supportive leadership, and resources within the framework of third-generation partnerships. These partnerships involve the private sector, focus on policy change and provide the foundation for the current design of P-16 and Cradle to Career initiatives. The third-generation design is a continuation of previous iterations of educational partnerships that addresses the complexities that have arisen “because of the ambiguity of the work…the labor-intensive nature of civic capacity partnership development…sustainability for these experimental cradle to career systems and the transaction costs of collaboration and partnership development to effect policy change” (Lawson, 2013, p. 643).
Programs

Curricular. There is robust support in these research findings for the perspective that early educational interventions are integral to closing achievement gaps between individuals from across socioeconomic status groups. The need for early childhood education and exposure to STEM was a prominent theme that emerged from the interviews. This need is well established in the document and literature reviews. With a renewed interest in supporting Head Start in New York State, the 2014 budget negotiations ended with an infusion of resources that focuses on early learning and interventions. Early childhood education establishes the foundation for English Language Arts (ELA); the research shows the importance of ELA proficiency in building reading comprehension skills that are integral to STEM mastery (George DeBoer, Carman, & Lazzaro, 2010).

Interviews and document reviews affirmed that the introduction to STEM in middle school is not the best approach. Some participants responded that it was too late to introduce STEM concepts beyond the sixth grade. Participants were near consensus that the third and fourth grades were the latest points at which STEM exposure should be introduced (The President’s Council of Advisors on Science & Technology, 2010).

Project based learning. The study’s results also confirmed the importance of Project Based Learning to STEM teaching and learning. Participant 1 recommended “redesigning curricula in the schools to encourage more hands on work by students, more Project Based Learning by students in school” (Interview 1). Studies have shown positive outcomes relating to the effectiveness of using the Project Based Learning approach to STEM education (Cho & Brown, 2013). This curricular strategy has evidence-based results at the K-16 level and has been
identified as a pedagogical best practice that supports the development of students’ positive attitudes toward STEM subjects (Tseng, Chang, Lou, & Chen, 2013).

Co-curricular. Systems of academic support have long been viewed as important to the learning process and career exploration outside of the classroom. Wright finds that “there is growing evidence that well-designed and structured afterschool community-based programs can promote positive youth development and enrich the lives of youth (Eccles & Gootman, 2002; Posner & Vandell, 1999), improve school performance (Catterall et al., 1999), as well as reduce negative behaviors like delinquency and alcohol and drug abuse (Mahoney et al. 2005)” (Wright, 2007, p. 123). Within the context of STEM, these programs are also known as STEM education enrichment activities. Enrichment can take various forms at the K-12 level, including afterschool, in-school and summer learning activities.
Youth Co-curricular Programs

*Boys and Girls Club of America.* Through document reviews and web research, programs were identified that are expanding activities to offer services to students that improve STEM education and also have a long history of serving students. One example was of the Boys and Girls Club of America (BGCA), which has instituted new initiatives that focus on university partnerships and STEM education. In existence for over 100 years, the BGCA has over four thousand locations and serves over four million youth. BCAs are established in economically disadvantaged communities across the country and leverage their history of community involvement to sustain support. BGCA has a reputation for working with underserved youth. The organization also has the brand recognition to recruit students and parents into newer STEM programming efforts.

This national program with a local impact offers various STEM programs in branch locations tailored to the communities they serve. BGCA is a community-based organization that leverages partnerships with academia and industry to advance STEM educational enrichment for economically disadvantaged youth. BGCA has implemented the “Every Member, Every Year” programmatic strategy. The strategy is designed so that all clubs, no matter their size or access to resources, can partner with youth, parents, schools and other community stakeholders to implement at least one of three approaches: academic enrichment and school engagement; targeted dropout prevention and intensive intervention and case management. This supportive infrastructure and early exposure to STEM offers a model that can be leveraged for collective impact.
New York Academy of Sciences Afterschool STEM Mentoring Program. In 2010, the State University of New York launched the New York Academy of Sciences Afterschool STEM Mentoring Program. This program uses graduate students and newly-minted PhDs to volunteer to teach and mentor underserved students in fourth and eighth grades one afternoon per week. The program partners with community-based organizations such as the Boys and Girls Club and the Young Men’s Christian Association. Mentors are incentivized to participate in order to build professional expertise and gain an Academy Fellow Teaching Credential for one semester of participation. This program is an example of implementing best practices such as mentorship and role modeling to advance STEM educational enrichment for economically disadvantaged students in New York.

Secondary education co-curricular program: Mass Insight. Mass Insight is a Boston Massachusetts-based nonprofit that partners with state high schools to develop strategies that will improve educational outcomes and close achievement gaps for students within the state. Mass Insight’s STEM program is called the College Success/STEM Initiative. It is currently being implemented in forty-three schools throughout the state. Its program has had early success in closing the STEM achievement gap for economically disadvantaged students. A recent outcomes analysis resulted in the finding that high school graduation rates for students with low income in Mass Insight schools increased by more than 4%, outpacing gains made in non-Mass Insight comparison schools and among all students with low income in Massachusetts. These goals were achieved by implementing best practices that build an infrastructure of professional development for teachers, curriculum and instruction. Educational enrichment efforts were also made to increase the number and pass rate for students taking Advanced Placement exams.
Co-curricular Collegiate Programs

Participants 4 and 5/Interviews 4 and 5 described the practices of the University of Maryland Baltimore County (UMBC) as a model example of co-curricular programs that have successful outcomes for students majoring in STEM, pursuing STEM careers or future doctoral study in STEM fields. Participant 4/Interview 4, President Hrabowski, was featured on 60 Minutes. He received accolades for his success with STEM. Participant 5 affirmed the model’s success:

Hrabowski’s program…You may be already familiar with it, but I do think it's a tremendous model. This guy has been able to grow this university in many ways. Probably next to the University of Maryland, it is the second largest research university in that Maryland system, where it wasn’t that probably as early as 10 years ago. That Meyerhoff Scholarship Program I think is a wonderful effort (Interview 5).

There are four programs for scholars at UMBC that target STEM students. The Meyerhoff Program is part of this group and is designed to support undergraduate students who will go on to pursue advanced degrees in STEM. There is also the Sherman Scholars Program that prepares students to pursue careers in teaching STEM. The remaining two programs focus on STEM workforce preparedness and include programs within the Center for Women in Technology (CWIT), which prepares women for careers in Information Technology and Engineering. The newest initiative is called the Cyber Scholars Program; it prepares students for careers or advanced study of cyber security.

There was evidence of best practices consistent with the literature review overviewing UMBC’s Meyerhof, Cyber, Sherman, and CWIT Scholars: “Each program is supported with intensive academic and career advising and professional development experiences, and students receive $5,000 to $22,000 in financial support, summer bridge programming. [They] engage in
living learning communities, research, internships, and fellowships” (University of Maryland Baltimore County, 2014 p. 1). Some of these programs have curricular components or serve as hybrid models of curricular and co-curricular approaches. As cited in the literature review, components of UMBC’s programs align with strategies for retention and success of economically disadvantaged students.

**Partnerships**

This study revealed that New York’s Science and Technology, Entry Program (STEP) and its affiliate program, the Collegiate Science Technology Entry Program (CSTEP), implement best practices that prepare students academically and professionally for post-graduation careers in STEM. STEP and CSTEP are STEM educational enrichment programs that target economically disadvantaged and underrepresented minorities within New York (New York State Education Department, 2012). STEP and CSTEP are models designed for partnerships in both funding and program delivery. “STEP receives a minimum of 25% in matching funds from such sources as private and other governmental contributors” (Perkins, 2013, p.7).

STEP and its affiliate, CSTEP, are not designed as pipeline programs. STEP does not require continuation in CSTEP when enrolling in college, but it does provide a pathway for a supportive transition and continued enrichment should STEP students decide to persist. The STEP initiative was awarded a Presidential honor in 2003 by George W. Bush because of the “program’s reputation as an exemplar for mentoring secondary students as they transition into academic programs where they can obtain undergraduate and graduate degrees that will lead to successful career opportunities” (Perkins, 2013, p. 8).

STEP and CSTEP students receive academic enrichment in science and math-related subjects. Students also participate in research projects; receive support with the college and
graduate school application process; and attend preparatory classes for regents and assistance with mastering standardized tests such as the SAT/ACT/GRE exam preparation courses. Students are also provided with mentoring and tutoring as part of the grant. The programs are built upon a framework that implements sound evidence-based practices and opportunities to expand partnerships to leverage the ability to serve economically disadvantaged STEM students.

**Research Question 2: Results Summary**

This section revealed that there are existing policies, programs and partnerships within New York and surrounding states that implement best practices which can be used to prepare students academically and professionally for STEM careers. Table 1 below is a categorization of participant comments that reflect the results of the barriers student’s face issues that result from poverty.

A review of curricular and co-curricular program designs detailed model criteria. These criteria are best practices that help to identify evidence-based programs with positive outcomes and new programs that show promising early results in serving economically disadvantaged students. Best practices include public-private partnerships in the development of programs that support STEM education for K-12 systems. The programs provide early exposure to STEM concepts, mentoring, tutoring, education enrichment activities, case management, test preparation, assistance with college and scholarship applications and FAFSA assistance.

Best practices were also delivered at the collegiate level through summer bridge programs, research opportunities, scholarships, STEM research support, living-learning communities, and internships. Partnerships included support in program funding, development and implementation. STEM industry partnerships also consisted of professional mentoring,
technology and equipment donations, professional development, curricular development, and other approaches to collaboration.
Table 1: Poverty Issues Impacting K-12 STEM Education by Topic and Interview Participant

<table>
<thead>
<tr>
<th>Role Models/Mentors</th>
<th>Parent Involvement</th>
<th>Teacher Development</th>
<th>Self-Concept</th>
<th>Foundational Knowledge</th>
<th>Early exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.“I find that a large majority of economically disadvantaged young men and women do not necessarily see people of color within the classroom that may or may not be encouraging them to focus and strive to master STEM studies. As a result, their emphasis or their focus is redirected to areas that are not STEM-related.”</td>
<td>2.“We have parents that are not thinking about the fact of pushing their children in these STEM areas and having high expectations that their children will succeed. That's for someone else they say.”</td>
<td>1.“You really have to have a very strong educator who sees potential and is picking opportunities to really transform and to reach the audiences that you have identified in getting them excited and engaged in a STEM field.”</td>
<td>2.“When it comes to science, technology, and math, we have so many children that don't believe it's an area for them, so they don't pursue it.”</td>
<td>2.“Many of them (low-SES students) do not have the fundamental education skills, because they haven't developed the requisite ELA skills. So they can’t read for the understanding they need and the ability to analyze and synthesize that is needed when also taking science, technology, engineering, and math. They sometimes struggle with that. So it’s first starting with the basics of the ELA, so that they have the English language arts skills to be able to take advantage of the science, technology, engineering, and math.”</td>
<td>4.“The interest in STEM does not occur at the college level and it doesn't occur at the high school level. It occurs at the elementary school level.”</td>
</tr>
<tr>
<td>4.“I think the whole cultural aspect of role models, the opportunities that exist—shadowing, mentoring, all kinds of programs where they see that this can be an option for them—will address one of the largest problems which is cultural and the feeling of being able to feel that I can succeed in this area.”</td>
<td>6.“The challenges are financial, early exposure, lack of parental support, lack of role models.”</td>
<td>2.“We have people who are in guidance and teachers who don’t push low SES kids, thinking that the social sciences are the areas that they should be invested in.”</td>
<td>4.“I think the whole cultural aspect of role models, the opportunities that exist—shadowing, mentoring, all kinds of programs where they see that this can be an option for them—will address one of the largest problems which is cultural and the feeling of being able to feel that I can succeed in this area.”</td>
<td>5.“I just don’t think we have enough efforts working downstream of the problem with the so-called pipeline. I think it’s a good metaphor for the fact that there are still far too few students of color, in particular, entering the STEM disciplines. In a large measure, it has to do with the fact that far too many of our kids are ill-prepared. From early childhood education or actually Pre-K through twelve to be successful in those careers, or to become interested.”</td>
<td>6.“Early exposure to the disciplines in the STEM fields that students might not have access to or think they have any interest in. I think one of the challenges is early exposure at least by middle school before students get into high school.”</td>
</tr>
<tr>
<td>Page</td>
<td>Text</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>“The challenges are financial, early exposure, lack of parental support, lack of role models.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>“Many of them (low-SES students) come from homes where their parents don’t speak English or don’t speak English well. Many of them are coming from homes where their parents themselves were not college graduates. How do you teach those families to fill out a [FAFSA] to get financial aid so that their student can go to college?”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>“It’s nice to say, ‘We’ll have a task forces on STEM.’ If you don’t prepare the teachers in third and fourth grades and make sure they’re proficient in teaching science and technology…Even though science and math and pre-engineering [are] pretty basic at the level of elementary school, you have to create the incentives and the learning models so that those students are turned on to those subject areas. You have to start with ways in which we train elementary school teachers. Because if you wait until junior high school or high school you lose that student.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>“You’ve got to be able to make them [students with low SES] feel that they can succeed.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>“We often refer to this as a pipeline which includes making sure that children are ready for kindergarten, and are successful in third and fourth grade’s ELA and math assessments, successful in taking the right high school courses and with the right degree of rigor and success to graduate high school and go on to college.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>“The challenges are financial, early exposure, lack of parental support, lack of role models.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>“Getting them out into an internship or a summer program where at least they’re mentored by somebody from the STEM field…is important.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>“There is a need for professional development for faculty and teachers.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>“If those kids [with low SES] aren’t ready to learn, and don’t have the support structure necessary to succeed, whether you give them money and put them in a classroom, it’s not going to make a difference. I would think that if you could demonstrate whatever universe you’re taking from and get the cream of the crop [of students with low SES] that you could find funding for them to get through the program.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>“If you haven’t gotten them [students with low SES] interested in STEM by the third grade it isn’t happening.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Research Question 3: What comprehensive public-private partnerships can be created or expanded to establish a large-scale career pipeline for STEM graduates in New York State?

Policy

This study established the need for policies to be developed that improve the ability for cross-sector partners to have access to information that supports the planning and assessment of collaborative workforce development programs. Information gaps stall or disrupt program planning, development, and assessment. In order to establish a large-scale career pipeline for New York’s STEM graduates, there is a need for policymakers to make employment data more readily available for the planning, tracking, and assessment of STEM workforce projections and employment outcomes in a way that does not compromise personal information and employer market competitiveness.

Reports by region, industry, and anticipated number of available positions based upon historical new hire data and planned startups, are ways in which certificate and degree programs can be developed. These are programs that meet the needs of employers, higher education officials, and students. Informed policymaking that meets these needs involves commissioning studies similar to the one conducted by the Center for Economic Growth (CEG) based in New York’s Capital Region. The CEG study identified six key industries as viable, next generation opportunities for upstate New York. The industries marked for growth include advanced materials, bio/life sciences, cleantech/energy, homeland security/defense, information technology, and nanotechnology/semiconductors (Technology Sectors, 2014). The need exists for ongoing review and analysis of key industries to inform policymakers, educational leaders and regional stakeholders.
**Programs**

This study revealed the need for more internships, apprenticeships, and co-operative education (co-op) programs in the state. Nationally, apprenticeships are on the decline and the United States remains far behind other Western nations with just 375,000 workers in registered apprenticeships nationwide. This count is significantly less than Britain’s 2.8 million and Germany’s 7 million. In April 2014, Vice President Biden announced the establishment of a new consortium of college representatives and business leaders that will focus on providing college credit for apprenticeships. Biden described apprenticeships as a pipeline of skilled workers for employers that must be expanded. Colleges that join the consortium are required to agree to give students credits for participation in apprenticeships (Field, 2014).

Internships are more common forms of educational partnerships that advance workforce development. They are structured to provide academic credit, wages, or volunteer experiences to bolster a student’s résumé. Internships vary in rigor, with some requiring close collaboration and in-depth professional experience. Others limit student responsibilities. Participants agreed that internships provide a pathway to employment after graduation. For example, Participant 1/Interview 1 highlighted efforts that make a difference in partnerships, describing how the industry could make advancements in hiring STEM talent:

“Making a monetary investment, providing summer experiences, supporting college funds for college courses, offering internships or co-op opportunities…” (Interview 1). When asked about partnerships opportunities, Participant 4 stated:

“I don’t know about co-ops, but there’s certainly internship possibility and there’s [a lot of] interaction with the private sector at the college level. So opportunities are shown” (Interview 4).
Participant 3 discussed the importance of incentivizing students to remain in the state by providing paid internships. The participant suggested the following:

I think if you could figure out a way to take successful stem graduates from high school, and or college and provides some internships, some paid internships, or some summer work or mentorships with folks and industry that would enable those two to see a career pathways developed (Interview 3).

Co-ops require close collaboration between educational institutions and academic departments with industry. They also provide a paid immersion experience into the world of work. This is done in close alignment with a student’s academic in-class learning. There is a global effort underway to increase the number of co-op experiences. According to the World Association on Co-operative Education (WACE), “education institutions, employers, and public authorities all share a profound commitment to preparing new generations for a lifetime of professional success in today’s global and diverse workforce” (Workers Advancing Co-operative and Work Integrated Education, 2014 p. 1). Students are competing globally for positions, especially in STEM. Participants in this research study affirmed that creating public-private partnerships provide co-ops for New York’s students to have a competitive advantage. These partnerships will also benefit the state by cultivating a competent, well-trained workforce. REDCs were mentioned as structurally adept at scaling a statewide co-op initiative because of their close partnership with higher education.

**Partnerships**

There is an increasing number of public-private partnerships with industries specializing in a diverse portfolio of STEM-related research, development and commerce at federal and state levels (Rifkin, 2013). Recent government efforts include incentivizing education programs that
build interest and capacity for students to pursue careers in STEM fields as a means of leveling the playing field for those who are economically disadvantaged. Disparate educational outcomes resulting from the achievement gap between socioeconomic groups in poor or economically depressed communities has been a point of focus for President Obama and state leaders (Lindjord, 2002; Reardon, Baker, & Klasik, 2012). The expansion of funding has resulted in innovative curricular and co-curricular initiatives to achieve STEM education goals, especially in low-income urban areas and increasingly in high-poverty rural communities.

Participants emphasized the importance of partnerships in the funding, graduating, and employing of STEM students. In acknowledging the significance of partnerships, there was also an acknowledgement of the complexity, bureaucracy, and challenges that derive from different organizational ecologies. The results depict these nuances as barriers to innovation and collaboration when they cannot be overcome. Participants shared experiences in which collaborative educational projects failed to launch or were derailed because of the challenges associated with cross-sector partnerships. As complex as the challenges to collaboration and movement are, implementing third-generation partnership systems are a necessity because they are linked to workforce and economic development (Lawson, 2013).

One example of a workforce development partnership program that links economically disadvantaged high school students to college and the labor market is Jobs for the Future (JFF); it is based in Boston, Massachusetts. JFF staff work in over twenty-five states to do the following:

[We] build contextualized career pathways that empower students to learn basic skills while at the same time participating in career-specific training. Real-time labor market information is used to connect education and training programs with current employer
needs and help colleges guide students into pathways that match their interests with local demand (Jobs For The Future, 2014, p. 1).

The JFF program does not focus on STEM careers, but it does provide a model that can be tailored toward developing public-private partnerships that result in employment that meets the needs of industry and students. JFF has an impressive list of partners and funders including the US Department of Education, Boeing, many private foundations, and various corporations. They describe their activities as working to fix all leaks along the education-to-career pipeline (Jobs For The Future, 2014).

**Research Question 3: Results Summary**

The data revealed the need for public-private partnerships that include stakeholder involvement in the planning and assessment of workforce development programs that create a large-scale pipeline for employing STEM graduates. Information gaps highlight the importance of data analytics. Understanding the implications of the data will assist partners in tracking legislation and policies—nationally and statewide—that serve as indicators to project regional growth opportunities. These indicators will enable effective planning for regional workforce development needs. The results indicate urgency for better reporting of employment outcomes associated with public-private partnerships of career pathway and workforce development programs.

This research study identified a need for more internships, apprenticeships, and co-ops to be created by industries to provide STEM students with an opportunity to gain practical workplace experience and earn wages. A review of the best practices establishes the importance of partnerships between industries and higher education in the development of experiential education. Such partnerships help to ensure that curricula align with updated, relevant skills in
the workplace. JFF is a model program that utilizes effective public-private partnerships that can be re-engineered for New York’s economically disadvantaged STEM students.

**Summary of Results**

Chapter four presented the results from interviews with key stakeholders involved in creating public-private partnerships that develop education to career pipelines for students in New York State. Document reviews and web content analysis provided additional insight into existing policies and programs. A recap of the research questions and a summary of results follow on the next pages.
Table 2: Research Questions and Summary Results

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Results Summary</th>
</tr>
</thead>
</table>
| **1: What public-private funding programs can be developed to reduce costs and debt**  
  **associated with college attendance for Pell-eligible STEM students in New York State?** | 1: A review of existing funding policies showed that there has been more progress made in the development of programs to fund STEM students in the state, but these programs are merit-based and fail to address the college affordability gaps based on socioeconomic status. Participants indicated opportunities exist to build collaborative models that address funding gaps for Pell-eligible students. |
| **2: What policies and best practices can be developed from existing curricular and**  
  **co-curricular programs to prepare students academically and professionally for postgraduate careers in STEM?** | 2: This section revealed that there are existing policies, programs, and partnerships within New York and surrounding states that implement best practices which can be used to prepare students academically and professionally for STEM careers. Interviews and document reviews found examples of evidence-based and promising practices at the K-12 and postsecondary levels that identify curricular and co-curricular solutions. |
| **Research Question 3: What comprehensive public-private partnerships can be created**  
  **or expanded to establish a large-scale career pipeline for STEM graduates in New York State?** | 3: The data revealed the need for public-private partnerships that include stakeholder involvement in the planning and assessment of workforce development programs that create a large-scale pipeline for employing STEM graduates. Participants indicated that a need exists for innovative new models that provide an infrastructure conducive to cross-sector collaboration. |
This analysis helped to uncover strategic public policy and collaborative partnerships designed to reduce student college costs, improve learning, and develop career pathways that lead to employment opportunity. The results lay the foundation for the research findings, recommendations and the model as a process guide for organizational scaling of STEM educational initiatives for economically disadvantaged students in New York.
Chapter 5

Findings and Recommendations for Practice

Overview

The purpose of this study was to identify new ways to improve educational opportunities for economically disadvantaged students who study and seek careers in STEM in New York State. Through semi-structured interviews, document review, and web analysis, key findings emerged within the categories of policies, programs, and partnerships. These findings inform the research goal of developing a model that serves as a framework based upon best practices. The interview data was obtained from 11 participants responding to a series of questions (see Appendix A). The questions were developed in order to yield data to help explore three research questions. This chapter presents the research questions followed by a summary overview of the most significant themes that emerged as research findings. Tables 3-5 below provide a summary of findings and recommendations that align with the emerging national focus on the development of cross-sector partnerships to create and fund innovative STEM programs.

Study Limitations

This study researched existing policies, programs, and practices that are designed to close achievement gaps for underrepresented groups in general and within STEM disciplines in particular. This study did not provide an assessment of existing models and programs. The findings are based upon reported evidence of positive outcomes and promising practices that advance STEM K-12 and college to career programs. This study is not a meta-analysis of existing STEM programs in New York or other states. Future studies should include a larger sample of existing programs so that comparisons across a broader group of initiatives can be
made. While the study did not conduct a program assessment, it did identify initiatives that showed promise and would benefit from further research and evaluation.

**A Framework for Implementation**

This study recommends the development of an innovative model that is designed based on an athletic framework that integrates STEM Cradle to Career and P-16 pathways into a model similarly structured to the National Football League (NFL) pipeline that begins from P – (Pop Warner) through 16, representing the conclusion of the post collegiate transition into career pathways to the NFL. The model is a framework for scaling programs at the K-12 and higher education levels. The framework provides a structure for the implementation of existing best practices. It is based upon a well-known structure that has been repurposed for education. The structure can be applied to current and future initiatives that are within and beyond the scope of this research.

**Research Questions, Findings and Recommendations for Practice**

**Research Question 1:** What public-private funding programs can be developed to reduce costs and debt associated with college attendance for Pell-eligible STEM students in New York State?

Policy development that improves college affordability and persistence of students with low SES: K-12 funding policies. Research findings confirmed the need to create policies that respond to the funding inequalities that exist in the nation’s K-12 institutions. Funding inequalities negatively impact academic achievement and rates of student persistence through high school toward college degree completion. The shift away from need-based to merit aid at colleges and universities, established in the literature review, has policy implications that affect a student’s ability to afford and complete college (Farrell, 2009; Heller & Marin, 2002). An example of a program that awards merit at the expense of need is the New York State STEM
Initiative program. This new program provides a free college education for the top 10% of New York’s high school graduates who major in STEM. These top performers must earn a degree and remain in New York for employment. Interview participants confirmed the merit of the new initiative and questioned how others who are not top performers may benefit from this type of support. The data on the efficacy of such programs advancing degree completion for economically disadvantaged students provides evidence that more is needed on behalf of the state to increase access to an affordable education for students with low SES who have STEM majors.

Although the state has access and opportunity programs that enroll economically disadvantaged students, existing programs do not provide free tuition for students majoring in STEM. Three established access and opportunity programs emerged from the research that have direct evidence of success in serving students with low SES at the postsecondary level. These programs include the Higher Education Opportunity Program managed by the New York State Education Department, the Educational Opportunity Program under the State University of New York (SUNY) system, and the Search for Education, Elevation, and Knowledge program operating out of the City University of New York (CUNY). Requirements for admission include the applicant’s low SES status and ineligibility for admission through the standard college processes. Admitted students must demonstrate motivation and potential for college completion. Evidence of demonstrated potential varies according to each college’s admissions requirements (CUNY, 2014; New York State Education Department, 2014a; SUNY, 2014).

New York’s programs that focus on STEM for students with low SES are the Collegiate Science and Technology Entry Program and the Perkins’ Career and Technical Education Improvement Act program which provide supplemental funds that enrich students’ academic and
educational experiences (New York State Education Department, 2014b). Research shows that this type of support is needed. (Chang, Sharkness, Hurtado, & Newman, 2014; Holman, 2013; Robinson, Rousseau, Mapp, Morris, & Laster, 2007; Whalen & Shelley Ii, 2010). This dissertation study supports the continuation and expansion of supplemental academic and career support.

The recommendations based upon the study’s findings support pathway programs that fund tuition for 90% of New York’s students who not covered under the NYS STEM Initiative, yet have displayed ability and interest in STEM majors and careers. The literature reviewed in this study supports this recommendation to establish and fund a pipeline to college for students with low SES in order to break cycles of poverty (Carnevale, 2010; Carnevale & Strohl, 2013; Elliott & Friedline, 2013; Huang, 2013). Participant 2 explained, “The Governor is proposing the Top Ten Percent program. Well, I think we need to worry about more than the top 10%, because there are people who are in that other 90% who could definitely move up as they get more support in developing their cognitive skills” (Interview 2). Participant 5 saw the NYS STEM Initiative Program as an opportunity: “There is a need for leveraging using the Top Ten Percent Program that provides scholarships. How can we leverage that [program] to start to work more consistently and effectively on programs that are designed to get kids [with low SES] interested in science and be prepared to be successful” (Interview 5)?

Higher education funding gaps can be filled by policy solutions that involve public-private partnerships toward degree financing. STEM programs developed at the state level can respond to funding gaps by targeting economically disadvantaged students and providing them with substantive tuition assistance. This approach can include high-achieving students with low
income as well as highly-motivated students who are moderately performing and seek to enter college or the workforce.

Gaps in programs that target low SES students for STEM educational to employment pipeline programs indicated that public-private partnerships should be broadened. Creating partnerships between private foundations, independent postsecondary institutions, and additional industry participants that reflect the STEM diversity in each region of the state (NY Regional Economic Development Council, 2014) new initiatives will be funded by multiple sources, alleviating some of the costs burden for the State. The research findings support the development and expansion of partnerships to scale up for maximum capacity in serving economically disadvantaged students attending low-performing schools. Below are examples of participants’ responses that demonstrate the importance of partnerships in funding students with low SES:

(Funding partnerships that provide employment are important), especially for socioeconomically challenged students to have good support structures as they move through high school and determine that they need to work. That’s where the state can be so helpful by bringing in partners in education, government, and private sectors to assist in providing STEM employment opportunities, especially for low income, students (Participant 4/Interview 4).

I think that one of the good ways to do this (fund Pell-eligible students) is to bring together partners from business, higher education, K-12 schools and the state to develop dual-enrollment programs that would lower college costs and give students a more rigorous foundation before going to college (Participant 2/Interview 2).
Participant 1 remarked, “Bringing the school district, higher education institution along with a STEM business within the region (together) can generate a partnership that closely aligns with the educational demands within high school” (Interview 1).

Research Question 1: Summary of Findings

The findings from this study revealed that New York’s existing postsecondary opportunity programs for economically disadvantaged students do not provide free tuition for a SUNY or CUNY education. Systemic disparities in K-12 education that lead to achievement and college persistence gaps perpetuate inequality by structural classism that interferes with opportunities for STEM students with low income to achieve top 10% status to be eligible for a free education at a state college or university. The state alone cannot address systemic disparities, structural inequalities, close achievement gaps, and increase college persistence. Public-private partnerships are needed to create policies and fund programs that reduce costs and debt associated with college attendance for Pell-eligible STEM students in New York State.

Research Question 1: Recommendations

This study recommends leveraging the newly-established New York State STEM Initiative Program to set aside 50% of slots for secondary school student recipients of the federal Free and Reduced Lunch Program (FRLP). These students should receive a free SUNY or CUNY STEM education based upon the criteria of the grant. This recommended approach equitably divides resources between need and merit-based financial aid. Kahlenberg (2012,), advocate of class-based affirmative action policies, supports economic equality in higher education as evidenced by his remarks:
If college admissions officers want to be fair—truly meritocratic—they need to consider not only a student’s raw academic credentials, but also what obstacles s/he had to overcome to achieve them. In this way, economic affirmative action is not meant to be a challenge to merit but rather a better approximation of it.

The New York State STEM Initiative is scaled at the state level. New partnerships can be developed to broaden its impact to include private foundations and industry to fund the adaptation that would fiscally allow for the support of 50% of FRLP students to enroll in CUNY and SUNY. This would be fully funded by the NYS STEM Initiative. Establishing public-private partnerships expands the program’s economic impact by serving a larger number of students, including those who are economically disadvantaged. Businesses benefit by having access to diverse human capital to fill STEM workforce needs in the state. Everyone benefits by regional economic growth when poverty and blight are diminished.

The second recommendation for the first research question is the creation of a collaborative student loan repayment and forgiveness partnership between industry, government, and the student borrower. The STEM student would pay down his or her student loan upon graduating from a New York school. The student borrower would also remain in the state for STEM employment for up to five years. The model should be constructed as a matching funds program that allows each partner to pay one-third toward the balance of the loan on an annual basis up to a total cost of $30,000 at no more than $6,000 paid out annually. Any remaining balance beyond $30,000 would be the responsibility of the student borrower.

The cost of $30,000 was selected because the average student loan debt accumulation for graduates of 2012 was $29,400 as reported by the most recent “Project on Student Debt” report
of 2012 (The Institute for College Access and Success, 2012). Employers can construct the program as an employee benefit and withdraw student loan repayments directly from paychecks with a combined employer 1/3 matching funds to go toward loan repayment. This model will use the same occupational code list used by the NYS STEM Initiative to establish employment criteria. GPA requirements of a 2.5 minimum are also recommended in accordance with North Dakota’s STEM Loan Forgiveness program (outlined in Chapter 4) to determine eligibility.

**Research Question 2:** What policies and best practices can be developed from existing curricular and co-curricular programs to prepare students academically and professionally for postgraduate careers in STEM?

**Building educational foundations for STEM readiness.** Prominent themes in the data revealed that establishing a strong foundation of English, math, and science in K-8 schooling, along with early exposure to STEM, were impactful best practices (George DeBoer, Carman, & Lazzaro, 2010; The President’s Council of Advisors on Science & Technology, 2010). As addressed in Chapter 4, to achieve this, elementary and middle school teachers are expected to exhibit aptitude in subject matter content and pedagogical proficiency in STEM. Grasping foundational knowledge also requires that students are ready to learn, supporting an increasing emphasis on early childhood education and early exposure to STEM education for economically disadvantaged students (Dejarnette, 2012; Druckenmiller, 2013; Williams Shanks & Robinson, 2013).

**Barriers impacting learning.** This study revealed that cycles of poverty leave many children unprepared to pursue advanced STEM subjects. Examples that demonstrate barriers to learning faced by the economically disadvantaged were repeatedly encountered in the research. Participants provided data on the most prevalent problems which included the following: a lack
of role models and mentors; very little parent involvement; the need for more teacher
development; low student self-concepts; and poor education foundational skills.

*Approaches and best practices.* This study identified evidence of programs and
partnerships within New York and surrounding states that combat the barriers imposed by
poverty. Socioeconomic challenges were overcome by implementing best practices used to
prepare students academically and professionally for STEM careers. A review of curricular and
co-curricular program designs detailed criteria that have been established in the literature. These
programs implement evidence-based practices with positive outcomes and new programs that
show promising early results in serving economically disadvantaged students. These programs
were discussed in more detail in Chapter 4.

Examples of best practices include the development of programs that support STEM
education for K-12 students. These programs also address poverty barriers by providing early
exposure to STEM, mentoring, tutoring, and education enrichment activities. Participating
students are also exposed to self-esteem building activities, case management support, test
preparation, incentivization of parent/guardian involvement, and college access counseling. The
focus of the postsecondary counseling is to provide assistance with college and scholarship
applications and FAFSA guidance. Best practices were also delivered at the collegiate level
through summer bridge programs, research opportunities, scholarships, STEM research support,
living-learning communities, and internships. STEM industry support consisted of professional
mentoring; social support services; technology and equipment donations; teacher professional
development; curricular development; and other approaches to collaboration.
Research Question 2: Summary of Findings

The data revealed significant findings that showed evidence of the effects associated with poverty. Socioeconomic disadvantage was found to be an obstacle in the preparation of students for academic and career success in STEM. The research found six prevalent barriers: lack of STEM role models and mentors in low-SES communities; low levels of parent involvement; the need for teacher development; poor self-concept among students; and lack of early exposure to the foundation subjects that support rigorous STEM classes. Best practices such as summer bridge programs, mentoring, tutoring and providing research opportunities were identified. These activities support STEM students in postsecondary institutions.

The second significant finding for the second research question was the identification of a distinctive need for the development of comprehensive policies that draw upon a holistic approach. This approach is needed to address the complex barriers that emerge as a result of poverty at the secondary and postsecondary levels. Postsecondary best practices were identified to assist with the achievement gaps that serve as barriers to retention of college students with low SES. These are students who are identified through social support services, summer bridge programs that transition students to college easier, undergraduate research opportunities, scholarships, STEM research support, and living-learning communities.

Research Question 2: Recommendations

This study recommends the design of a statewide initiative that funds afterschool and community STEM-enrichment programs modeled after the national Race To The Top (RTTT) program. Participating schools would compete for the opportunity to receive funding to launch a STEM initiative by agreeing to develop, implement, and assess programs that address the effects of poverty and the six issues that emerged in the data from this study. This approach aligns with
the RTTT four core education reform areas that relate to STEM educational enrichment for underserved communities (US Department of Education, 2010). Organizations seeking funding would develop proposals based upon program development that addresses at least four of the six poverty barriers including the following: providing STEM mentors and role models; increasing parent and guardian involvement; raising self-concept; promoting opportunities for teacher development; enhancing educational enrichment that supports English, math, and STEM subjects; and targeting early learners.

The second recommendation for the second research question includes the capacity development of teachers to serve as in-house STEM coaches. Through the identification of a core group of teachers who show evidence of interest and aptitude in science and math, districts are able to hire teachers–coaches who are enthusiastic about the content. This study’s literature review has established the impact teachers have on motivating and inciting student interest in STEM subjects. The sole responsibility of the STEM teacher–coach would be delivering Common Core science and math content in an interactive, project-based learning format to students in grades K-6. This approach should be considered as an alternative to requiring advanced STEM coursework for all teachers.

A third recommendation for the second research question includes creating methods to identify and report demographic profiles of students enrolled in the most competitive and rigorous academic programs. Institutional data collection that sets benchmarks can chart the progress of enrolling more FRLP students in rigorous and competitive secondary programs. This includes International Baccalaureate programs, Advance Placement courses, College in the High School programs and others that position students for college and career readiness. Once tooled with data, stakeholders and pipeline program affiliates can better identify barriers to progress and
develop actionable plans that involve a whole school/whole child approach to address disparities and alleviate systemic inequalities.

The fourth recommendation for the second research question includes designing a case management model that provides academic and social support for STEM students participating in P-12 extended and afterschool programs. The case management model is also recommended at the postsecondary education level, especially for institutions that serve high numbers of Pell-eligible students. The case manager would work with students and families, connecting them to necessary resources. With basic life needs met, economically disadvantaged students can turn their attention to the rigors of STEM coursework.

The fifth and final recommendation for the second research question is the development and implementation of specialized programming for categories of diversity that intersect with socioeconomic status to address issues around self-concept and intersecting identities. Programs similar to Brotherhood-Sister Sol, which offer direct guidance and support to underrepresented minorities and female students through rites of passage programs, mentoring, support groups, and college and career access counseling. These approaches provide direct evidence of success and promising practices (Brotherhood-Sister Sol, 2014).

**Research Question 3: What comprehensive public-private partnerships can be created or expanded to establish a large-scale career pipeline for STEM graduates in New York State?**

**Barriers to collaboration.** The findings revealed that multi-sector partnerships consist of industry-specific structures, culture, language, and processes that complicate collaborative engagement. Cross-sector partnerships are comprised of complexities, bureaucracy, and diverse
organizational ecologies that impede and delay the advancement of innovative, scalable state-level educational reform (Lawson, 2013). This research study demonstrates ways that difficulties associated with collaboration serve as barriers in the development of successful affiliations that advance STEM education efforts for economically disadvantaged students. Participant 5 stated, “We just don't have a seamless collective impact strategy I think to get this done. Perhaps if we could develop such a collective impact strategy around this kind of issue, we would maybe get greater engagement from the corporate sector than we have now” (Interview 5). Participant 6 provided one reason for this lack of seamless collaboration: “I don’t think schools are organized to partner easily with business and industry. I don’t think business and industry are organized easily to partner with K-12 [schools] and I think the same schism exists between K-12 and higher education. So I think those are the greatest barriers” (Interview 6).

This study found evidence of partnerships, but the interviews affirmed the challenges collaborators face as they advance an agenda for reform. These barriers to partnering impede progress in supporting economically disadvantaged students in STEM education. This research study also found New York partnerships that were established to implement best practices and address achievement gaps identified in the literature. The data showed evidence of small and midsized programs throughout the state that responded to issues associated with poverty; some of the programs also provided STEM programming. The amount of programs decentralizes efforts, which also leads to a competition for resources.

**Internships, co-ops, and apprenticeships.** The findings also revealed the need for more internships, co-ops, and apprenticeships to prepare students for STEM careers and the importance of public-private partnerships that connect career pathway programs to employment for economically disadvantaged students (Fifolt, SUNY Coop Launch, WACE, Field, 2013).
Participant 6 stated, “I think getting students enrolled in internship programs in high school where they actually experience STEM-related careers [is important]” (Interview 6). On the topic of co-ops the interviewee went on to say that “WACE conducted a study on the core programs of students who do a supervised co-op experience—mostly in the STEM fields in business and industry. [They] have above a 90%, placement rate. In other words, [they get] a job from one of the co-op businesses in which they were placed.”

Of particular significance is the opportunity for paid experience at the secondary and postsecondary levels for students with low SES. Participant 1 stated the following:

You could engage [students] and provide—starting in the tenth grade—summer experiences, co-ops, internships with pay, and on-the-job real experiences as well as educational experiences. You will be amazed to see how they absorb that experience, challenging themselves educationally, making a little money, getting away from home, working in a very positive environment, learning and meeting members in the business and industry, getting a sense of development, earning college credit, and getting some positive motivation. [It’s] something that would be a great incentive to the audiences that we have because so often they don’t go outside of their neighborhood and the neighborhood is not going to talk about what we are talking about here STEM and coop and internship (Interview 1).

Participant 2 affirmed the impact of paid work experiences for students and the role that local government could play by using existing programs in partnership with secondary and postsecondary institutions:
We did one program with the county of XYZ where they would pay Summer Youth Employment money to be at the College of Nanoscience. And so they (students) would go there every day as a job. They would get paid. They had to be on time, because that would affect their pay. But what they were doing is working with equipment—$300,000 microscopes… working with million-dollar equipment. And I saw students that saw that they can do this and it opened up their minds (Interview 2).

The research makes clear the major finding that experiential learning in the form of co-ops, internships, and apprenticeships have a positive impact on future employment opportunities for students.

**Pipelines to nowhere? Documenting employment outcomes of career pathway programs.** The findings revealed information gaps. These gaps depict the need for better reporting of employment outcomes associated with public-private partnerships that support career pathway and workforce development programs. When interviewees were asked if they knew of any other first-in-line programs similarly structured to P-TECH, no one could think of any which came close to guaranteeing employment if criteria and conditions were met by the student, the institution, and the employer. Participant 11 expressed that guarantees were not realistic expectations for the following reasons: “[Employers] want to keep their firms competitive to the point that colleges might do their best to train them [students with STEM majors] but some other schools might do better. Companies say why I should limit myself” (Interview 11). Participant 8, representing industry, described internships that developed from K-12 partnerships as one of the best pathways to employment: “I would not say that we would guarantee employment but definitely we would consider these [STEM high school] students
because they’ve already done an internship with us and we’ve funded a lot of the programs that they take part in in high school” (Interview 8).

Partnerships were more often found to offer skills training and career development for students that positioned them for employment. Positioning is important for development of a network and the research supports the benefits of mentoring and role models toward that purpose (Fifolt, Griffin, Ware, 2013). While establishing a network assists in career preparation and fits into a framework of best practices, networking does not establish a formalized structure leading directly to employment.

A pipeline that goes beyond college completion, resulting in STEM-related jobs and career placement, is needed to close the loop for graduates. Career preparation, technical aptitude, and skills development for students should play a central role. However, efforts must extend beyond traditional approaches toward more innovative first-in-line structures that position students competitively for career opportunities.

**Research Question 3: Summary of Findings**

The findings demonstrate that in order for public-private partnerships to be effective at creating a large-scale pipeline for STEM graduates in New York, barriers should be addressed. There is a need for a framework of collaboration that incentivizes innovation and advances dialogue. This dialogue must go beyond discussions of conflict toward the goal of developing interventions to complex issues. These issues pertain to educational inequality, poverty, human capital for efficient labor markets, and regional economic development.

The second finding for the third research question affirmed the data from participants about the benefits of creating co-ops and internships for students and employers. One of the
benefits included advancing workforce development goals and increased skill attainment. The third finding identified gaps in the research that relate to the identification and reporting of employment outcomes data for existing Cradle to Career initiatives and pipeline programs. This may be due to the newer STEM-focused programs being in their infancy and students remaining in the pipeline. The need for tracking of employment outcomes to determine the effectiveness of partnerships between industry and higher education is of interest to government, higher education regulators, and policymakers (Dill & Soo, 2004).

**Research Question 3: Recommendations**

This study recommends the development of new innovative models that address the complex design of systems. Knowledge of and respect for organizational typologies must be intentional. Deliberate actions to build awareness, trust, and respect are important ingredients for laying a foundation of innovation and success. Borrowing from the corporate sector, Boston Scientific Cofounder John Abele uses a method called “growth through collaboration”: “collaborative breakthroughs come from outside of the system by having non-establishment parties run the show so that they don’t have the bias of whatever establishment they come from” (Rifkin, 2013, p. 41).

Responding to Abele’s call to identify ways to address the principles of non-establishment approaches; lay foundations for innovation and success; and creating environments for collaborative breakthroughs to occur, this study recommends application of a new model found in Appendix B. The model was developed in part based upon dialogue from a White House meeting of the Office of Science, Technology and Policy in February 2014 where the idea proposing the creation of an athletic model was introduced in a breakout session. Meeting
participants were charged to generate innovative solutions to STEM access for underrepresented groups in higher education.

The second recommendation for the third research question is the creation of a statewide partnership initiative led by secondary and postsecondary education leaders of public and private institutions. This public-private partnership would collaborate to develop a statewide co-op incubator. This new nonprofit would partner with the New York State Department of Labor, the State Taxation Department, Regional Economic Development Councils, and other stakeholders. The governing board should include industry representation from New York’s 10 regions; STEM experiential education and career opportunities should be a primary focus. This approach allows for the establishment and promotion of internships, co-ops, apprenticeships, and entry-level STEM positions throughout the state of New York.

The third recommendation for the third research question involves industry, higher education, and state agencies partnering to close the loop on information gaps by establishing forecasting tools to direct workforce development efforts. One approach is to predict workforce needs based on hiring patterns by working with the New York State Department of Taxation and Finance. Companies are required to report data to the Department of Taxation and Finance on newly-hired or rehired employees who will be employed in New York State within twenty calendar days from the hiring date.

This data coupled with the Department of Labor’s Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW) data can be analyzed to determine employment outcomes and conduct a backward mapping of job opportunities. This approach can also be used to forecast employment patterns in STEM industries and provide wage data that will help
students make informed career choices. Acknowledging that certain STEM-certificate and degree programs are developed in response to existing and future job vacancies, this real-time analysis equips higher education leaders with data that can identify hiring patterns that inform partnership agreements for workforce development.

**Finding Summaries and Recommendations**

The following tables provide a summary of select findings in Chapter 5 and recommendations to be considered by practitioners for development and implementation. The model represented in Appendix B offers a framework for scaled collaboration to fund, graduate, and employ STEM students with low SES in New York State.
Table 3: Research Question 1: What public-private funding programs can be developed to reduce costs and debt associated with college attendance for Pell-eligible STEM students in New York State?

<table>
<thead>
<tr>
<th>Summary of Findings</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Public-private funding programs that reduce college costs and debt for economically disadvantaged students can be developed through the scaling of existing programs and the development of new partnerships.</td>
<td>1) Create public-private partnerships that establish and fund a STEM pipeline to college for students with low SES in New York to break cycles of poverty. Existing P-16, Cradle to Career, and College Access and Opportunity programs should be adapted to include a component that focuses on STEM education. New programs like P-TECH and the NYS STEM Initiative should develop, implement, and scale efforts that provide a free pathway to postsecondary STEM education and careers for New York’s economically disadvantaged. An approximation of merit that not only includes high achievers but also considers obstacles to overcome and motivation to succeed should be used.</td>
</tr>
</tbody>
</table>
Table 4: Research Question 2: What policies and best practices can be developed from existing curricular and co-curricular programs to prepare students academically and professionally for postgraduate careers in STEM?

<table>
<thead>
<tr>
<th>Summary of Findings</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) This study illuminated curricular and co-curricular program designs with detailed criteria that have been established in the literature as evidence-based practices with positive outcomes and new programs that show promising early results in serving economically disadvantaged students. Evidence in the findings support the distinctive need for development of comprehensive policies that draw upon a holistic approach to address the complex barriers that emerge with poverty at the secondary and postsecondary levels.</td>
<td>1) Incorporate infrastructures of social and academic support by adding case management services to existing curricular and co-curricular programs that focus on educating P-16 students in STEM with low SES. Supportive programs should promote positive self-concepts; they should not be constructed and promoted in a manner that focuses on deficit reduction. The design for policies and programs should incorporate the best practices identified in this and other research findings. Programs should not only respond to current best practices, but should also incorporate emerging innovations into strategic planning processes and program operations.</td>
</tr>
</tbody>
</table>
Table 5: Research Question 3: What comprehensive public-private partnerships can be created or expanded to establish a large-scale career pipeline for STEM graduates in New York State?

<table>
<thead>
<tr>
<th>Summary of Findings</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) The findings revealed that multi-sector partnerships consist of industry-specific structure, culture, language, and processes that complicate collaborative engagement. Evidence emerged showing that these differences are barriers to progress for existing partnerships developed to create education and career pipelines for New York’s STEM students.</td>
<td>1) Create a new model of scale based upon evidence-based outcomes, promising practices, and innovative designs that allow all partners to adapt to an alternative framework for collaboration instead of conforming to an existing organizational structure associated with a partnering agent. This study proposes using a modified framework of the National Football League’s organizational design, adapted for collective impact in STEM education.</td>
</tr>
<tr>
<td>2) The findings also show a need for more internships, apprenticeships, and co-ops to be created by industry employers to provide STEM students an opportunity to gain practical workplace experience and an opportunity to earn wages.</td>
<td>2) Secondary, postsecondary, and industry state leaders should partner. An outcome of the partnership should be the development of an experiential education and employment incubator. This incubator would centralize efforts to create, increase, and promote internships, co-ops, apprenticeships, and entry-level STEM positions throughout the state of New York.</td>
</tr>
<tr>
<td>3) Information gaps highlight the need for data analytics that will develop better reporting of employment outcomes of public-private career pathways and workforce development programs.</td>
<td>3) Convene data analysts, institutional researchers in higher education and personnel from state agencies. These experts would focus on identifying metrics and developing policies that track and report employment outcomes for student participants of existing and future STEM pipeline programs.</td>
</tr>
</tbody>
</table>
Conclusion

A review of the research finds that existing income inequality is impacted by rising rates of underemployment, unemployment, and increasing student loan debt for college attendees and graduates (Federal Reserve, 2012; Reed & Cheng, 2009; Stone, Horn, & Zukin, 2012; the Institute for College Access and Success, 2012). The academic achievement gap is a contributing factor to income inequality. This gap negatively impacts society’s most vulnerable and economically disadvantaged students. Expanding STEM college and career opportunities has been established as one approach toward improving economic mobility. Efforts to create a pipeline from college to the world of work have been shown to be promising. These efforts are most effective when infrastructures of learning and support are in place. Effective infrastructures should build students’ interests and capacities to study STEM; this should start early in a child’s academic career. This approach is implemented within the framework of Cradle to Career and P-16 pipeline programs.

This research study explored STEM and other educational programs and policies that provided evidence of successful outcomes or promising practices. These programs and policies should be considered for scaling at the state level for New York. Focus was placed on initiatives that impact funding, educational, and employment pipeline opportunities. The goal included the identification or development of programs that could be scaled for collective impact. Semi-structured interviews, document review, and web content analysis resulted in findings that support the need for a statewide STEM program of scale for economically disadvantaged students.
This study has shown that systemic inequalities experienced by economically disadvantaged students in the nation’s educational systems are cyclically perpetuated. Educators and policymakers need to focus on developing solutions that result from the effects of poverty in response to P-12 schooling inequalities. This research showed that partnership intervention in education prioritizes curricular reforms and educational enrichment. Unfortunately, such intervention places less emphasis on ensuring that the barriers to learning are minimized or removed for students with low SES. For children and families living at or below the poverty level, and those qualifying for federally subsidized programs like the FRLP and Pell, failure to overcome these barriers leads to intergenerational poverty (A. P. Carnevale & Strohl, 2013; Huang, 2013).

Systemic changes are warranted to stop the cycle of poor educational outcomes tied to learning barriers associated with poverty. The focus on merit is a misguided approach that serves as a poor estimation of who deserves opportunities and who is denied. Merit does not take into consideration a student’s household and community conditions, in conjunction with the obstacles associated with under resourced schools in high poverty communities. The prioritization of school and learning fluctuates based upon the fluid social conditions and crises that take precedence. These are all factors that impact a student’s ability to learn and achieve.

To suggest that economically disadvantaged students have an equal opportunity to reach the top 10% of STEM achievers in the state is negligible and intentionally ignores the conditions of New York’s poorest performing schools and impoverished communities. The diversity of rigor in educational experiences at the secondary level leads to a gap in the level of preparation and the ability to persist in STEM study at the postsecondary level. These conditions give pause to consideration of socioeconomic diversity in the state’s public schools and how to ensure that
students with low SES are provided with the needed infrastructures of support that give them the opportunity to enroll in IB, AP, and College in the High School Prep programs. A commitment to funding wraparound services for P-12 and case management for P-16 will be a determining factor in how well state officials address equity issues in STEM education.

To close the achievement gap, educators and policymakers need to be willing to partner in the funding of holistic approaches to education. Such approaches ensure that students are prepared to learn the rigorous content required to excel in STEM subjects at all levels. The pipeline approach is a partnership intervention model that is structured well for the incorporation of additional academic and social support services. Expansion of the pipeline to motivate and inspire students of low SES backgrounds to study STEM is needed. These recommendations are intended to encourage educators and policymakers to take action and prioritize educational funding that improves conditions in P-12 schools. Educational and policy leaders are encouraged to provide infrastructures of social and academic support for P-16 students and offer a free pathway to college for economically disadvantaged students majoring in STEM. The model in Appendix B is intended to be an innovative design to improve communication and collaboration between partnering organizations. It also offers a framework for centralizing and scaling the funding, programs, and processes of New York’s STEM initiatives in a way that invites stakeholder participation through clearly defined roles. Effective policymakers realize the importance of broadening the constituency base for a collective impact.

Future research should include case studies of STEM curricular and co-curricular initiatives that serve economically disadvantaged students; the impact of best practices on the individuals served should be assessed. Are there particular programs and services that are more effective than others? What policies are in place that fund academic and social supports for
students with low SES? Have these services had a positive impact on student retention and graduation rates? Further studies should also model the creation and scaling of initiatives that focus on closing the achievement gap for other underrepresented groups in STEM within New York such as women and racial/ethnic minorities of Black, Latino and Native-American students. Initiatives that support Asian-Americans whose origins are from impoverished or developing Asian nations, such as Vietnam, Laos and Cambodia should also be studied.

The recommended policy and program implementation will provide an opportunity to address the unique challenges that negatively impact an economically disadvantaged student’s ability to study and gain employment in STEM careers. Having the information provided in this study will yield additional guidance to policymakers and practitioners regarding how to design an education to employment collective impact strategy for economically disadvantaged STEM students in New York State and elsewhere in the nation and the world.
References


Druckenmiller, S. (2013). Building the future for our kids, our community and our country (pp. 20). New York, NY: Harlem Children's Zone.


Elliott, W., & Friedline, T. (2013). “You pay your share, we’ll pay our share”: The college cost burden and the role of race, income, and college assets. *Economics of Education Review*, 33(0), 134-153. doi: http://dx.doi.org/10.1016/j.econedurev.2012.10.001


Ware, J., & Stein, S. (2013). From "mentor" to "role model": Scaling the involvement of STEM professionals through role model videos. *Journal of Educational Multimedia and Hypermedia, 22*(2), 209-223.


Appendix A

Interview Questions

Shai L. Butler - CPS DLP IRB Form

Research Question 1: What public-private funding programs can be developed to reduce costs and debt associated with college attendance for Pell-eligible STEM students in New York State?

- How can the state, higher education and private industry partner to enroll, graduate and fund economically disadvantaged STEM students in a way that is mutually beneficial for all stakeholders?

Research Question 2: What policies and best practices can be developed from existing curricular and co-curricular programs to prepare students academically and professionally for postgraduate careers in STEM?

- Are there unique challenges in enrolling, retaining, and graduating economically disadvantaged students who pursue STEM majors? If yes, what are they?
- What examples can you share of policies that have been able to successfully respond to these challenges?
- Describe to me in your experience, what are some of the most successful STEM career development programs that you have seen implemented (precollegiate and collegiate)?
- What are some examples of innovative curriculum development that you’ve seen between STEM faculty and industry? If none, what do you think could be done?
Research Question 3: What comprehensive public-private partnerships can be created or expanded to establish a large-scale career pipeline for STEM graduates in New York State?

- If you were building this model, how would you go about introducing it and getting buy-in from the various stakeholders across organizations (corporate, higher education and state partners)?
- What, if any, challenges to policy and program development do you perceive may arise?
- In consideration of the wide range of career opportunities for students majoring in STEM, what policy solutions can incentivize graduates to remain in New York for employment?
- Where are the greatest opportunities for partnership to advance economic development in the state?
Appendix B
Model Introduction

The purpose of this study was to develop new approaches to funding, graduating, and employing economically disadvantaged students in New York State who are pursuing STEM majors and careers. To achieve this goal a collective impact model was designed based upon study recommendations and best practices identified in the research. The model consists of two components: an organizational structure that is based upon the organizational chart of the National Football League (NFL) and a recommendation for competitive funding processes based upon the federal Race to the Top Program (RTTT). As in RTTT, which directs grantees to design programs based on four identified criteria, this model uses criteria based upon study results, findings, and recommendations in the funding component. This model is meant to serve as an incentive to advance the establishment of a new innovative partnership that will prove to be a promising practice in serving economically disadvantaged students who are seeking STEM education and careers in New York.

The NFL model was chosen as a framework for implementation because it addresses the research findings associated with organizational structural incompatibilities, the need for complex interventions and coordination challenges associated with the creation of a scalable comprehensive model. The federal RTTT program has been widely adapted nationally and the NFL is an iconic organization known for producing national athletic champions. The purpose of this design is to create a unifying framework based upon two well-known programs with the goal of producing national STEM champions from New York’s economically disadvantaged student population.
Explanation of Organizational Chart Positions and Roles

**New York State Education Department (NYSED):** The NFL. NYSED was selected as the lead organization for this initiative because it serves as the regulatory body of education for the state of New York, just as the NFL is the regulatory body for all team associations. While NYSED serves as the convening and oversight body, this office acts in partnership with the “owners,” those private foundations seeking innovative solutions to closing educational achievement gaps, and STEM corporations in need of human capital to create a pipeline of talent to fill regional workforce needs. This model relies upon New York’s Regional Economic Development Councils who serve a key role in meeting the college and career demands that this framework is designed to address.

**Private foundations and corporate STEM and non-STEM industry investors:**

**owners.** In the NFL, the owners invest and hold a financial stake in the success of the league, the teams, and the players. In the NYS STEM Education and Career Opportunity Program, the owners are at the top of the hierarchy and work with the regulatory body and the general managers (GMs) to set goals, objectives, and make senior strategic-level decisions. Tactical decisions are left to GMs and the head coach. The model is similar to the NFL in that there can be multiple owners for one team. For example the Mara and Tisch families are owners of the New York Giants.

The framework consists of a multi-owner consortium of owners at the state level to invoke a larger collective impact. The senior advisory group includes the regulatory authority or NYSED; the owners or private industry and foundation funders; GMs or state education leaders in K-12 schools, extended learning programs, colleges and universities; the assistant GM or REDC working group chairs on education and careers; the head coach or STEM program executive director; and the Network or STEM Students with low SES advisory group. If this
approach is undertaken it requires establishing a formula for equitable distribution of resources by region; this is crucial to the program’s success. The alternative framework would involve having 10 consortiums of owners by the 10 REDCs based upon the tech industries within the regions. This decentralized statewide approach can work in the short term as a pilot, but pooling state resources for collective impact is the ultimate goal to ensure equity, parity, and positive results.

**NYSAN, NYSED commissioner, SUNY, CUNY and the Commission on Independent Colleges and Universities (CICU): GMs.** GMs provide operational leadership based on specific content knowledge of their areas of oversight and should consist of individuals at the top of the organization’s leadership. This group drives the discourse on STEM education reform and funding, working in an advisory capacity with the regulators and owners. The GMs are responsible for creating operational plans that support the overall strategic organizational goals developed by the senior advisory board. The model recommends keeping this function centralized at the state level. If, however, there is a decision to decentralize the program by regions, the steering advisory committee should consist of regional college presidents, NYSAN leaders and school superintendents. These professionals should meet with regional STEM industry investors and representatives from NYSED.

**Regional Economic Developing Councils’ working groups on college and career readiness: assistant general managers.** Education and workforce development initiatives play key strategic positions in each of the REDCs and should therefore be included as part of the senior advisory group. Connections between regional industries involved at the senior advisory level and those involved at the regional planning level are integral to the model’s success. Education and career leaders in workgroups can serve as intermediaries for institutions and
organizations in the consolidated funding application process. These leaders can support new initiatives that advance regions toward achieving economic development goals. A broader view of the goals and objectives of STEM regional industries can strategically connect college to career pipelines. REDCs can bridge the information gap between planning and funding at the regional and the state levels.

NYS STEM education and career opportunity executive director: head coach. Reporting to NYSED, the executive director/head coach is the tactical implementer of the strategic plan and objectives outlined by the regulators, investors, and senior level advisors. The executive director also supervises the professional fellows hired over a two year commitment. The head coach is responsible for management, supervision, marketing, fundraising, and assessment activities.

**STEM student advisory board—The network.** The student advisory board should consist of secondary students with an intent to enroll in STEM and postsecondary students majoring in STEM who are recipients of free and reduced lunch or Pell grants. Having representative voices of the students this model will support the creation of strategic goals that align not only with researched best practices but the particular concerns identified by students with low SES from New York, in their own voices. In addition to socioeconomic status, the senior leadership advisory group should ensure that class diversity is reflected within the student network. These intersecting groups should include other categories of students underrepresented in STEM such as minorities and women who are students with low SES.

**Professional fellows.** Modeled after Governor Cuomo’s Empire State Fellows Program: “a full-time leadership training program that will prepare the next generation of talented professionals for careers as New York State policymakers,” individuals hired for the STEM Education and Career Opportunity Program will agree to a two year employment commitment
Experts who have an academic background related to the position, experience working with STEM students or in STEM fields and mid-level experience directly within the scope of the position to which they are applying will assume the following roles:

**Scholastic/academic: offense coordinator.** Closing the academic achievement gap is the major purpose of this initiative; this is one of the most crucial roles. This person would be responsible for gathering data, developing policies, and approving programs that relate to any obligations within the Common Core curriculum. They would also provide extra academic supports to students with low SES. The professional fellow will travel throughout the state to meet with STEM teachers, curriculum specialists, STEM college majors, and chief academic officers to gain the knowledge to develop policies and programs that improve the academic achievement of students with low SES who are studying STEM.

**Regulatory affairs: defensive coordinator.** This professional fellow is responsible for staying current on all federal, state, and local regulations that impact K-12 schooling, higher education, enhanced extended care and STEM partnerships. This individual will work in partnership with other fellows to draft policies that align with evidence based and promising practices. The regulatory affairs fellow will closely follow national, state and local education law and track memorandum from the Department of Education Office of Civil Rights and issues pertinent to College General Counsels.

**Finance and accounting: STEM operations.** In partnership with the executive director and NYSED, this professional fellow will have oversight of the budget and accounting responsibilities. They will respond to grant inquiries that are budget specific. The finance fellow will also assist organizations with budget development, manage accounts payable and monitor
expenditures. They will work closely with auditors to ensure fiduciary responsibilities are met.

**Social support infrastructure: player development.** This role is tasked with the need of identifying and ensures students in need of special services have in place an infrastructure of support so that they can focus on the rigor of STEM subjects. This will include working closely with in-school case managers, guidance counselors to ensure wrap around services are being met for students most in need. The Social Support fellow should also work closely with postsecondary institutions to develop case management services for students who are recipients of extra supports at the secondary level. **K-12 extended learning and college student services (special teams).** This professional fellow works closely with the leadership of afterschool programs that have a STEM focus or STEM component. The fellow should also work with student affairs staff at Colleges and Universities to identify innovative approaches to low SES STEM student retention and STEM program development and evaluation. **Educational institutions and employers: STEM teams.** The teams include school districts, afterschool programs, institutes, colleges and universities who decide to apply for State funding to join the New York State STEM Education and Career Opportunity Program. Prioritizing pipeline partnerships combines resources within regions and localities that further advance goals to provide opportunity to low SES students. As is the case with the CFA process and the increasing number of STEM education grants, partnership initiatives are required or preferred. An example can include a partnership initiative that connects a P-TECH program to a K-8 STEM program in a school district that is supported by a community based organization’s STEM afterschool program targeting students with low SES.

Participating employer teams in regions 1-10 are directly connected to the REDC working group leaders for college and career readiness as well as the foundations and
corporations funding this STEM opportunity initiative. The employer’s STEM teams are the sources of career preparation and hiring at secondary and postsecondary levels. These teams also provide post graduation employment opportunities. This team is responsible for creating and centralizing internships, co-ops, apprenticeships, and post graduation employment opportunities.

**Constituent advisory board: players.** The organizational structure being proposed is similar to the NFL in that it is designed to support its investment and most valuable asset: the players. The players’ voice in the planning process should not only be reflected through the voice of researchers and practitioners, but through the individuals themselves. Structures that allow for formal and informal communication from students and their support network of parents, guardians, and secular and religious organizations that focus on youth, should be built into the model.
Funding New York State STEM Education and Career Opportunity Program Funding

This study recommends that New York State officials use a funding framework similar to the federal RTTT program. This program is rescaled at the state level to fund the New York State STEM Education and Career Opportunity Program (New York STEM-ECOP) for economically disadvantaged students. RTTT is a competitive grant program used to encourage and reward states that are implementing significant reforms in the four education areas described in the American Recovery and Reinvestment Act of 2009: enhancing standards and assessments, improving the collection and use of data, increasing teacher effectiveness, and achieving equity in teacher distribution, and turning around struggling schools (US Department of Education, 2010). Unlike the RTTT funding model supported through taxpayer dollars, this study proposes that program financing be developed through public-private partnerships in conjunction with STEM corporations, private foundations, state budget allocations, and individual philanthropy for collective impact.

New York State, similar to the federal government, can create a competitive grant program from the funds vested in the STEM-ECOP account to incentivize the 10 regions within the Regional Economic Development Councils to take part in the program. This study recommends using the STEM-ECOP model adapted from the NFL to centralize efforts to create economies of scale for maximum savings and impact. Regional decentralization using the STEM-ECOP model is a recommended alternative structure for piloting the new initiative with a goal of scaling up as outcomes are assessed.

Under RTTT, each state grant recipient must address each of the four criteria to be eligible for funding. This research recommends awarding school districts, expanded learning (afterschool) programs and postsecondary institutions that are undertaking significant reforms in the areas identified as barriers in this study and in existing research on closing achievement gaps.
The study’s findings also indicated a need for initiatives that support students with low SES in K-12 STEM majors by addressing the following: a lack of role models/mentors, infrequent parent involvement, unsatisfactory teacher development, poor self-concept, and a lack of early exposure to foundational subjects such as English, math and science. In a review of the literature on best practices, studies also found that tutoring, wraparound services, college access counseling, test preparation support, opportunities to earn and learn through internships, and access to scholarships and grants assist economically disadvantaged students to succeed in STEM. At the collegiate level, the following best practices have been identified as effective in serving STEM majors: mentoring, bridge programs, academic support in STEM subjects, learning communities, career advising, and professional development and faculty mentorship.

This study recommends that criteria be selected from the list of findings and best practices that apply to each organizational type. For example, afterschool programs cannot address teacher development. Therefore it would not be conducive to this process to require that all criteria by each provider must be met in order to receive funding. Due to organizational diversity, criteria that are applicable for implementation and assessment should be selected by the NYS STEM-ECOP senior leadership advisory group. These criteria should be written into the request for proposal (RFP) based upon the initiatives that will create the most positive impact on students with low SES who study STEM in New York.

In addition to criteria selection, applicants should be prepared to show how they have researched the needs of the individuals they are tasked with serving. Applicants should also identify needs that are specific to their constituency and community in STEM education and workforce development. The researcher recommends that the RFP incorporate the voice of the students, K-12 parents, the business community and other stakeholders identified as the target
population in the proposal. This outreach can be accomplished through conducting focus groups, surveys, and semi-structured interviews as well as other methods that are approved through Institutional Review Boards and are in compliance with New York State laws and policies. Proposals developed in alignment with best practices, coupled with constituent feedback would be successful applications in the proposed RFP process. As in RTTT, transparency, accountability, and reporting standards will be a central component in determining grant awardees.

Summary

This model has been developed to create a comprehensive framework that supports partnerships and collaborations in the education of economically disadvantaged students studying STEM in New York State. It is designed as a baseline framework to create a pipeline beyond career preparation and workforce development to employment placement by using an industry model that differs from current cross-sector partners’ organizational ecologies. This model is an adaptation using an organization that is unique to the United States and effective in creating national athletic champions.

This study recommends borrowing from this model and expanding it to include other comparative frameworks including development of a Pop Warner model for K-8 STEM reform, the National Interscholastic Football model for secondary STEM education and the National Intercollegiate model for college STEM retention efforts. This model can be redesigned to accommodate various partnership initiatives and adapted based upon the needs of the state, region, or student participants. Based upon the researcher’s experience with cross-sector partnerships, what is important to retain through any adaptation is the voice of the consumer. In this instance, New York’s economically disadvantaged students and their social support network
should remain a part of the planning, implementation, and assessment—at the senior advisory and grassroots levels.
Appendix C

| Northeastern University, Department: College of Professional Studies-Doctorate in Law & Policy |
| Name of Investigator(s): [Dr. Kristen Lee Costa, Shai L Butler] |
| Title of Project: *From Stratified to Equalized: Development of a higher education, government and industry collaborative model that funds, graduates and employs economically disadvantaged Science, Technology, Engineering and Math students in New York State* |

| Informed Consent to Participate in a Research Study |
| We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep. |

| Why am I being asked to take part in this research study? |
| We are asking you to be in this study because you have expertise in the content matter being researched. |

| Why is this research study being done? |
| The purpose of this research project is to identify new ways to meet the increasing demands of funding higher education while also creating pathways to employment for low income students that meet the labor market demands within the State of New York. |

| What will I be asked to do? |
| If you decide to take part in this study, we will ask you to participate in a recorded interview that will later be transcribed into a text document for purpose of content review and analysis. |

| Where will this take place and how much of my time will it take? |
| You will be interviewed at a location and time that is convenient for you. The interview will take about one half hour. You will receive a copy of the questions at least 48hours in advance for you to review based on your preference. Advance review or written responses are not required for participation. If I identify gaps in information I will ask you if I can initiate contact again to ask any clarifying questions. |

| Will there be any risk or discomfort to me? |
| Associated risks that my result from divulging confidential information may come in the form of political retribution or be employment related. You will only be asked to provide public data and any opinions shared will be protected under laws of confidentiality. I will ensure confidentiality as it pertains to all interview responses. In the writing of drafts and the final research project, I will exclude all identifiable information of interviewees. I will not list the names or titles of individuals interviewed. I will refer to you only in general terms, such as “a manager at the New York State Education Department” or a “leader in state education policy”. |

| Will I benefit by being in this research? |
There will be no direct benefit to you for taking part in the study. However, the information learned from this study may help to advance opportunities for economically disadvantaged students to pursue and obtain both a college degree and employment.

**Who will see the information about me?**

Your part in this study will be confidential. Only the researchers on this study will see the information about you. No reports or publications will use information that can identify you in any way or any individual as being of this project.

All electronic documents will be password protected and all hard copies will be locked in an office file. The researcher will be the only one with the password and the key to the locked file drawer. All documents will be destroyed upon successful completion of the study and its defense. Signed consents will be scanned to a document file and retained on a flash drive at the home office of the researcher for three years following the end of the study. Data gathered and forwarded for purposes of transcription will be secured under the security policies of the national data firm Rev.Com

In rare instances, authorized people may request to see research information about you and other people in this study. This is done only to be sure that the research is done properly. We would only permit people who are authorized by organizations such as the Northeastern University Institutional Review Board.

**What will happen if I suffer any harm from this research?**

No special arrangements will be made for compensation or for payment for treatment solely because of my participation in this research.

**Can I stop my participation in this study?**

Your participation in this research is completely voluntary. You do not have to participate if you do not want to and you can refuse to answer any question. Even if you begin the study, you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have.

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

If you have any questions about this study, please feel free to contact [Shai Butler at butler.s@husky.neu.edu], the person mainly responsible for the research.

**Who can I contact about my rights as a participant?**

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

**Will I be paid for my participation?**

No. There is no compensation for participation.
Will it cost me anything to participate?
No.

Is there anything else I need to know?

This study is being conducted as part of the fulfillment requirements for a Doctorate in Law & Policy degree from Northeastern University’s College of Professional Studies.

I agree to take part in this research.

Signature of person agreeing to take part ________________________________ Date ________________________________

Printed name of person above ________________________________

Signature of person who explained the study to the participant above and obtained consent ________________________________ Date ________________________________

Printed name of person above

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~