THE IMPACT OF HIGH SCHOOL SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) MAGNET PROGRAMS ON THE ACADEMIC PERFORMANCE OF STUDENTS

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Dedication

We dedicate this dissertation to our families who have sacrificed greatly alongside us as we have made this journey. Thank you for supporting us even as we missed family activities, left parts of our homes covered with books and papers, and participated in group meetings late into many nights and almost every Saturday for more than a year. We would be remiss if each one of us did not specifically address our individual dedications.

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Abstract

Concern about the impact of science, technology, engineering, and mathematics (STEM) programs on society are not new. STEM employment in the United States has grown twice as fast as other fields during the last decade. School districts have been encouraged to consider STEM-focused schools to meet this demand and have responded by offering STEM magnet program options. This mixed-methods study used Lewin's Theory of Change and Fullan's ideas on Coherence as the theoretical frameworks to examine how students who participate in a high school STEM magnet program perform academically. Academic performance was measured using grade point average (GPA) and graduation rate. We compared the number of mathematics and science courses students in a STEM magnet program completed to the number of courses completed by students not participating in a STEM magnet program. Additionally, we surveyed teachers and administrators to learn their perceptions of student success factors in STEM magnet programs. There was a positive difference in graduation rates with a low effect size. The differences in the number of math and science courses completed were not practically significant. Moreover, magnet students earned a statistically significant higher GPA than non-magnet students. Furthermore, teachers reported a high degree of teacher efficacy, while administrators rated themselves higher on general leadership ability than on STEM leadership. We recommend clearly defining STEM education, additional professional development for teachers and administrators, streamlining accountability for STEM programs, and continuing to invest in STEM education as a pathway to producing college and career ready students.

THE IMPACT OF HIGH SCHOOL SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) MAGNET PROGRAMS ON THE ACADEMIC PERFORMANCE OF STUDENTS

CHAPTER 1

INTRODUCTION

Background

Concern regarding the impact of science, technology, engineering, and mathematics (STEM) programs on society is not a new phenomenon. The United States (U.S.) began creating STEM-like programs in the 1870s when mathematics and engineering students were taught using manual training methods designed by professor Calvin Woodward employing the mantra "technological literacy for all" (Sanders, 2009, p. 24). During the 1950s, the U.S. was reacting to the launch of the Soviet Union's Sputnik satellite and questioning its own STEM capacity. This concern led to the passage of the National Defense Education Act of 1958, which promoted, among other things, improved mathematics and science education in elementary and secondary schools (Judson, 2014). The concern expressed as a response to Sputnik, along with suggestions for increased STEM education, has been repeated many times since then. For example, *A Nation at Risk* (National Education Association, 1983) called for teacher training in mathematics and science, and the National Academy of Sciences (2007) produced a study, *Rising Above the Gathering Storm*, that advocated for scholarships for mathematics and science teachers.

According to the National Research Council ([NRC], 2011), many jobs in the 21st century require some level of STEM knowledge. Over the last two decades, 38% of the U.S. economy, as reflected in the gross domestic product, has relied heavily on knowledge-and-technology-intensive industries. These knowledge-and-technology-intensive industries depend significantly on science and technology economic activity to drive growth (National Science Foundation [NSF], 2018). Nevertheless, developing nations, such as China—whose output in high-technology manufacturing has risen sharply over time and now exceeds that of the European Union (NSF, 2018)—have challenged the U.S. stronghold on this industry.

The need for STEM. The demand for professionals in the fields of STEM careers in the U.S. is unprecedented (U.S. Department of Education [USDOE], 2016). According to the U.S. Department of Labor (2007), STEM employment has grown more than twice as fast as other fields during the last decade. The need for more STEM-focused education was captured by former President Barack Obama (White House Office of the Press Secretary, 2010) during his announcement of the *Change the Equation* initiative when he challenged business leaders and educators to bring an unparalleled number of new and innovative mathematics and science programs to local communities. This commitment to STEM education is even referenced in the *Every Student Succeeds Act* ([ESSA], 2015), which identifies STEM as a vital element in providing a well-rounded educational experience for all students. During his presidency, President Obama also supported a call to recruit and train 100,000 STEM teachers and open 1,000 new STEM-focused schools by 2020, mostly in elementary and middle schools (President's Council of Advisors on Science and Technology, 2012). In fact, President Obama promoted an agenda to invigorate the country's focus on STEM by addressing "the economic competitiveness of the United States [as] dependent on an adequate supply of high-quality workers in the STEM field" (Angle et al., 2016, p. 43). In response to President Obama's call to action, a STEM Coalition made up of business and educational advocates was formed. This emphasis resulted in educational institutions across the U.S. developing and incorporating STEM programs from the elementary level through the post-secondary level to meet the demand for high-quality workers in the progressively changing STEM fields (NSF, 2017).

A study by the Bayer Corporation claims there is a great need to produce new scientists and engineers in the U.S. if we are to remain a viable competitor in the global marketplace, harnessing talent from a diverse and multicultural student pool is essential in these efforts (Hrabowski, 2012). This threat to our national economy has captured the attention of education policymakers at the state and federal levels. As such, interest has renewed in STEM education and its impact on developing an educated workforce that can meet the demands of a growing technological marketplace.

Currently, the call for a STEM-capable workforce continues. In 2015, the NSF highlighted the need for STEM knowledge and skills in the 21st century, not only in STEM careers but also in many jobs in non-STEM fields. According to Backes, Goldhaber, Cade, Sullivan, and Dodson (2018), "A growing number of policymakers argue that for the United States to remain a worldwide economic and technological leader, it must do more to improve the quality of K-12 science, technology, engineering and mathematics (STEM) education" (p. 184). Current trends with a focus on STEM education have resulted in extraordinary amounts of funding through various sources to promote STEM education and to create and enhance STEM learning environments.

Funding STEM. Policymakers and economists predict that without additional investments in STEM education to produce a workforce that will enter STEM careers, the U.S. will continue to have significant shortfalls in the gross national product and the gross national income (Donovan, Moreno Mateos, Osborne, & Bisaccio, 2014). The federal government signed a spending bill into law on March 23, 2018, that increased funding for various programs and initiatives in the ESSA. The bill encourages and supports STEM education (NGSS Lead States, 2013) by increasing funding $1.438 billion over the prior year's budget, allocating $21.337 billion specifically to develop STEM programs across the country with an emphasis on underserved and underrepresented students and the communities in which they live. Additionally, ESSA calls for innovative programs that include high-quality STEM courses with hands-on learning (NGSS Lead States, 2013).

The National Science Board (2005) in its *2020 Vision* for the NSF highlighted, "Near-Term Goal 3: NSF will critically evaluate current education investments and develop new strategies to increase their impact on the quality of science, technology, engineering, and mathematics (STEM) education" (p. 7). The NSF (2017) is a financial sponsor of STEM programs, investing more than $880 million per year directly to its education foundation and human research funding. Due to this financial commitment, the NSF has a goal to evaluate its investments and ensure that STEM-focused programs are of high quality. These hefty investments should provide promising evidence that instructional programs with this focus are providing desired results.

STEM in schools. To eliminate STEM shortfalls, school systems, colleges, and universities offer a range of STEM-focused educational programs. The goal of these programs with a concentration in cybersecurity, information technology, engineering, scientific research, medical fields, and environmental sciences, is to ensure the U.S. remains competitive within the global economy (Hinojosa, Rapaport, Jaciw, LiCalsi, & Zacamy, 2017).

School districts have been encouraged to consider the adoption of STEM-focused schools as one way to meet this demand (NRC, 2011). The NRC (2011) identifies three models for such schools: 1) selective STEM schools (or programs within schools) for academically talented and motivated students which have selective admission requirements; 2) inclusive STEM schools, which emphasize a STEM discipline but have no selective admissions requirements; and 3) schools and programs with STEM-focused career and technical education. However, magnet school programs with a STEM focus, which most closely resemble the selective model, are the fastest-growing model in Miami-Dade County Public Schools (M-DCPS).

Magnet schools. The concept of magnet schools emerged in the 1960s as an effort to integrate schools voluntarily by offering innovative programs in predominantly Black neighborhoods at the height of the school desegregation battles (Rossell, 2005). Civil rights protection was a strong component in these schools initially. However, these schools did not have a selective admissions process. These schools were a response to the civil rights movement and provided an answer to questions about equity and access for all students. Federal government funding, aimed at desegregating schools and increasing parental choice, provided magnet schools with a period of unprecedented growth in the U.S. during the 1960s and 1970s (Orfield, Frankenberg, & Garces, 2008). Since then, with increasing financial support from the federal government, magnet schools have gained popularity in the U.S. However, the concept of magnet schools was a new one with many untested assumptions. Waldrip (2011) opined that one of the lessons learned from this era is that all students do not learn in the same ways and that educators must consider students' interests and aptitudes if students are to achieve at higher levels. Waldrip (2011) also asserted that every child can learn and that there must be enough options so parents of all children (or students themselves) will have the opportunity to choose the programs best suited for them.

STEM magnet schools at the local level. M-DCPS (2015) has implemented magnet programs for more than 40 years. Mirroring the pattern of magnet schools nationally, M-DCPS created multiple magnet schools and programs with various themes and emphases. "The objectives are to create educational interests, honor cultural and ethnic diversity, and promote student achievement" (M-DCPS, 2018b).

In 1990, the district opened its first whole-school STEM magnet program, Maritime and Science Technology Academy (MAST Academy). The school met with such success that the district franchised the school and created three additional MAST Academies in other areas of the county. In addition to these and a few other Whole School Magnet programs, M-DCPS opened numerous innovative STEM-focused magnet Programs Within Schools at various locations throughout the district (M-DCPS, 2015). These programs typically have established entrance criteria including course prerequisites, minimum academic and conduct grade point average, and an acceptable attendance record. The district has spent more than $45 million since 2006 to fund these programs. It currently manages a multi-year $15 million magnet school grant to fund the operation of three new inclusive high school STEM magnet programs (Robert Strickland, personal communication, October 1, 2018).

The response to the national call in M-DCPS has been the evolution of 38 high schools with STEM magnet programs (M-DCPS, 2019a). Of the 38 high schools, 11 are schoolwide STEM magnet schools with every student enrolled in one of the school’s STEM strands. Most of the district’s 61 senior high schools offer students at least one STEM program of study. M-DCPS has applied for and been awarded numerous grants to support and establish STEM magnet programs. Is this money being well-spent? The present study was designed to help answer this question.

Theoretical or Conceptual Framework

The theoretical frameworks we have chosen to underpin this study are change theory and coherence. Each is summarized in turn.

Change theory. The theoretical framework for this study is change theory. *The Theory of Change* by Lewin is the foundation of most change theories today (Schein, 1999). Kurt Lewin describes change management as Changing as Three Steps; that is, unfreeze, change, refreeze (Burnes, 2004). Many regard his model as a simple, practical approach to the change process. In unfreezing, the focus is on recognizing the need to change and, through a process he calls force field analysis, understanding that it will be more beneficial to change than to leave things the same. Change is the implementation stage—all the steps that occur during the process of adopting new practices or new ideas. Freezing (or refreezing) is making the change the new norm; it is a process of reinforcing the change, so it becomes operational and continues. Lewin’s ideas are met with some disagreement today, but overall, there seems to be agreement that his views are foundational to the concept of change management (Schein, 1996).

Fullan (2006) has his own ideas about change. He identifies seven core aspects of change: (a) motivation; (b) capacity building focused on results; (c) learning in context; (d) capacity to change the broader context; (e) reflective action; (f) tri-level engagement (school/community, district, and state); and (g) persistence and flexibility. Fullan ties motivation and engagement together concerning educational reform and suggests that all seven aspects of change require motivated stakeholders who engage across all levels if the change is to be effective.

Fullan (2001) discusses the importance of coherence making. This entails facing some of the challenges of change head-on and working through the discomfort that change can cause. Fullan and Quinn (2016) continue the discussion focusing on coherence and suggest that the pace and complexity of change are altering our ideas of an effective change process. Change is not linear. It is not an event. It is a process of moving from one practice to another. Fullan and Quinn (2016) summarize the change process in four steps. Directional vision involves developing a shared purpose and vision along with those who will take part in the change. Focused innovation is allowing the change participants the opportunity to innovate, experiment, and at times fail as part of moving toward a needed change. The diffusion of next practice involves providing intentional opportunities for new, innovative practices to be visible to everyone in the organization. Sustained cycles of innovation require organizations to sustain change by allowing for innovation, sharing innovative practices across all levels of the organization, and acknowledging successes all along the way.

Lewin’s, Fullan’s, and Quinn’s ideas on change are relevant to the current research. If STEM education produces significant results, it will be essential to have strategies in place to embrace the changes necessary to continue to build and implement STEM programs. Also, as STEM evolves, understanding how to manage change will allow for continued growth and innovation.

Theoretically, changing the environment and academic climate in public schools is possible. Change theory concepts, when applied to school academic achievement, entail unfreezing, changing, and refreezing the schools’ instructional programming (Burnes, 2004). Translated into the school setting, this represents ownership changes by the highest levels of leadership within the organization, breaking down barriers for teaching professionals, and lastly, mobilizing and empowering school sites to create ownership of new accepted norms and concepts (Burnes, 2004).

Coherence theory. Are STEM programs delivering the desired effects? It is imperative that educators strategically plan and invest in the right drivers to positively impact the education of U.S. students. The Fullan and Quinn’s (2016) Coherence Framework has four principle tenets important to this study: (1) focusing direction and providing a clear strategy for STEM education; (2) developing a collaborative culture with teachers to understand how to integrate various disciplines in STEM; (3) creating ways for students in STEM to engage in deeper learning; and (4) providing measures of accountability to ensure academic achievement results. These four tenets help explain the connection between change and the importance of institutionalizing adopted changes in terms of STEM magnet programs. Additionally, to reform M-DCPS’s culture and ensure that systems have the right drivers, it is necessary that education decision makers understand the purpose of equity and access in magnet programs. Moreover, once leaders understand the purpose, they must act in accordance with the purpose by developing programs, in this case, STEM magnet programs, and opening them in areas that will provide equity and access to those students who most need it.

Problem Statement

STEM education has emerged as a way to meet industry demands and to create a STEM-capable workforce (NRC, 2014). The policy shift to promote and fund STEM education is evident in our K-12 schools, and M-DCPS has taken full advantage of funding opportunities by expanding STEM high school magnet programs throughout the county. Although the record shows a significant amount of growth in K-12 STEM programs at the national level, no consensus has emerged on what STEM is (Mitts, 2016). In M-DCPS, schools interested in establishing a STEM magnet program are provided with the flexibility to implement a program best suited for their unique student population. The programs vary greatly and may range from robotics to engineering, biomedicine, information technology, and more.

The problem we investigated in this study is, how do students who participate in a high school STEM magnet program perform academically? For this study, academic performance was measured by grade point average (GPA) and graduation rate. We also examined the number of mathematics and science courses students in STEM magnet programs completed, compared to the number of courses students not participating in STEM magnet programs completed. Moreover, we administered surveys to STEM teachers and administrators to learn their perceptions of the effect of STEM magnet programs.

Research Questions

This research identified and explored the impact of a STEM magnet curriculum on the academic performance of participating students, compared to students not participating in a STEM curriculum. Specifically, we investigated the following research questions:

1. How do students who participate in a high school STEM magnet program perform academically?
    - a. What is the graduation rate of students in STEM magnet programs compared to students from target schools not participating in the STEM magnet program?
    - b. What is the average GPA of students graduating from STEM magnet programs, compared to students graduating from target schools not participating in the STEM magnet program?
2. How many mathematics and science credits do students in STEM magnet programs successfully earn during four years of high school, compared to students from target schools not participating in the STEM magnet program?
    - a. How many mathematics credits beyond the four required courses for graduation do students in STEM magnet programs successfully complete?
    - b. How many science credits beyond the three required for graduation do students in STEM magnet programs successfully complete?

3. What are administrator and teacher perceptions regarding STEM instruction?
    a. What are administrators’ perceptions of their leadership for STEM instruction?
    b. What are teachers’ perceptions of their efficacy and beliefs, impact on student outcomes, and STEM instructional practices?
4. What factors contribute to or inhibit a student’s successful completion of a STEM magnet program?

Significance of the Study

There is a void of empirical data in M-DCPS as to the effectiveness of STEM programs in relation to increasing student academic performance. This creates a challenge in justifying the expansion of such programs. Investigating the causes of this void is beyond the scope of this study. However, studying the impact of STEM magnet schools is important in underscoring their value as it relates to M-DCPS’s singular goal of improving student achievement and ultimately rising to the challenge of producing a STEM-savvy workforce that can compete in a knowledge-and-technology-intensive environment.

Political pressure for developing additional STEM magnet programs has added a layer of complexity and a further need to study the effectiveness of these programs. Within an environment of limited financial resources and competing interests for these resources—such as Advanced Placement, International Baccalaureate, and Cambridge Programs—is the expansion of STEM magnet programs a wise decision? This study explored the impact high school STEM magnet programs have on the academic performance of students. The evidence derived from this study can provide valuable information that may have an impact on the decisions of M-DCPS on whether it should continue to expand STEM magnet choice options throughout the county. Our study had mixed results. We found that students completing a four-year STEM magnet program earned a higher weighted GPA than students completing a non-STEM academic program within the same school, suggesting there is a slight advantage to participating in a STEM magnet program.

Since the call for STEM education continues to grow, both locally and across the U.S., it is essential to consider the effectiveness of STEM education. This study will add to the growing body of research related to the effectiveness of STEM magnet programs. The literature to date regarding the effectiveness of STEM programs reports mixed results (Blazer, 2012). Some studies (e.g., John, Smith, Thompson, & Wicklein, 2016; Poppell & Hague, 2001) suggest that magnet students have higher achievement than non-magnet students, while other studies find comparable performance (Cullen, Jacob, & Levitt, 2005; Judson, 2014) between the two groups. Other studies (Wiswall, Stiefel, Schwartz, & Boccardo, 2014) find that students in non-STEM programs outperform students in STEM programs when considering students' prior achievement. Limited research exists, however, on the effects of participating in an M-DCPS STEM magnet high school. The findings of our study may be useful to the M-DCPS leadership as they make decisions about continuing to invest in STEM programs. The study results may also provide information to other school systems as they, too, consider the academic options they will offer their students in the future.

Definitions of Terms

For this study, the following definitions apply:

- *A-Respondent* – Administrator Respondent
- *Academic Disparities* – A lack of equality or similarity in academic opportunities and outcomes.
- *Academic Performance* – GPA, graduation rate, and the number of mathematics and science courses students successfully complete.
- *Advanced Placement Program* (AP) – A program in the U.S. and Canada created by the College Board, which offers college-level curricula and examinations to high school students.
- *Cambridge Program – Advanced International Certificate of Education* (AICE) – An international curriculum and examination system offered to high school students.
- *Career and Technical Education* (CTE) – Schools, institutions, and educational programs that specialize in skilled trades and career preparation.
- *Change Theory* – A three-stage model of change that is known as the unfreeze-change-refreeze model that requires prior learning to be rejected and replaced.
- *Coherence* – A framework for implementing change in schools that focuses on four elements: focusing direction, cultivating collaborative cultures, securing accountability, and deepening learning (Fullan & Quinn, 2016).
- *Cohort 1* – Students who entered ninth grade in one of the 12 study schools in the fall of 2011-12.

- *Cohort 2* – Students who entered ninth grade in one of the 12 study schools in the fall of 2012-13.
- *Cohort 3* – Students who entered ninth grade in one of the 12 study schools in the fall of 2013-14.
- *College and Career Readiness* – Preparing students to possess the academic and behavioral skills colleges and employers expect from their workforce.
- *Divergent Thinkers* – Individuals who generate several creative ideas and explore many possible solutions to problems.
- *Effectiveness* – The degree to which something is successful in producing a desired result.
- *Every Student Succeeds Act* (ESSA) – This law, passed in December 2015, governs U.S. K-12 public education policy and demonstrates the nation's commitment to equal opportunity for all students.
- *Graduate* – A student who entered one of the 12 study schools and completed all of the graduation requirements at the same school.
- *Graduation Rate* – For this study, the graduation rate was calculated by school and by Cohort and then in aggregate (all the students in all the schools by cohort.) We identified the number of students who began and remained at one of the 12 study schools and completed the graduation requirements within four years and one summer. This number was divided by the number of students who entered 9th grade in the same Cohort and the same schools less the number of students who withdrew to a verified alternate location (in county, out of county, out of state, or a private school).

- *Innovation* – A new idea, method, or transformation.
- *International Baccalaureate* (IB) – A program that offers a continuum of international education to high school students.
- *Student Outcome Expectancy* – A teacher's belief that effective teaching can bring about student learning, regardless of external factors.
- *Socioeconomic Status* – An individual's or family's economic position in relation to others.
- *STEM* – Science, Technology, Engineering, and Mathematics.
- *STEM Magnet School Programs* – Programs within free public schools with a focused science, technology, engineering, and mathematics theme operated by the local school district. These programs often have a delineated set of entrance criteria such as a minimum academic and behavioral grade point average and record of attendance.
- *STEM-Capable Workforce* – Individuals who can use science, technology, engineering and/or mathematics knowledge and skills in a variety of settings to devise or adopt innovations or to complete occupational and technical tasks.
- *Student Achievement* – A student's success in meeting short- or long-term academic goals, for example, grades.
- *Teacher Beliefs* – A teacher's opinions about teaching and learning.
- *Teacher Efficacy* – A teacher's belief in his/her ability to guide students to success.
- *T-Respondent* – Teacher respondent

CHAPTER 2

REVIEW OF RELATED LITERATURE

It is undeniable that the global marketplace is becoming increasingly reliant on technology and innovation. As such, countries are examining ways to remain competitive in a technologically savvy and global economy. Many have turned to K-12 Science, Technology, Engineering, and Mathematics (STEM) magnet schools as a conduit to prepare students who can meet market demands in the field of STEM (ACT, 2017; Angle et al., 2016; Marshall, 2010; Mativo, Smith, Thompson, & Wicklein, 2016; McKnight, 2016). This literature review explores several topics that are important to the understanding of issues related to the effectiveness of STEM magnet programs. Topics include a definition of STEM, the need for STEM workers, Federal and State policy to support STEM in the U.S., STEM education, the contemporary needs of students in STEM classrooms, the history of magnet programs, and the proliferation of STEM magnet programs and related funding. The literature, along with a discussion of magnet schools in M-DCPS, provides background for the current study.

Science, Technology, Engineering, and Mathematics

Judith A. Ramaley, then director of the National Science Foundation’s (NSF) Education and Human Resources Division, takes credit for introducing the term STEM to represent the integration of Science, Technology, Engineering, and Mathematics (Chute, 2009). Previously, some attention was given to the integration of the four disciplines, using a different term, SMET, which emphasized mathematics and science. In education, STEM refers to programs that include one or more of the four subjects (Science, Technology, Engineering, and Mathematics). The NSF (2019) currently recognizes biological sciences, physical sciences, mathematical sciences, computer and information sciences, geosciences, engineering, and technology areas associated with these disciplines as STEM programs.

The call to increase the STEM workforce. There has been a concern about the importance of science almost since the U.S. was founded (Stevenson, 2014). In his first State of the Union Address, George Washington acknowledged the importance of scientific knowledge (Stevenson, 2014). During the 1950s, U.S. leaders worried that Russia was producing twice as many scientists and engineers than the U.S. As such, the discussion in the U.S. turned to a need for more STEM workers during the 1950s after the launch of the Sputnik satellite (Gonzalez & Kuenzi, 2012).

In each decade since Sputnik, the call to increase the STEM workforce continued. During the 1980s, the NSF reinforced the need to increase the STEM workforce, particularly Ph.D. scientists (Stevenson, 2014). The conversation during the late 1990s further stressed the need for a STEM-capable workforce as Information Technology firms reported a worker shortage (Stevenson, 2014). The rapid growth of internet use led to the need to fill many internet-related jobs.

During the mid-2000s, the call to produce more STEM workers began to be linked to a need for increased education. With a goal for the U.S. to remain globally competitive, *Rising Above the Gathering Storm* (National Academy of Sciences, 2007) called for an increase in K-12 and post-secondary STEM education to provide a pipeline to meet the workforce need. This influential publication warned about the perceived weaknesses in the existing U.S. STEM education system and the threat it posed on national prosperity and power (Gonzalez & Kuenzi, 2012). In 2012, the President's Council of Advisors on Science and Technology projected demand for "one million more STEM professionals than the United States will produce at the current rate" (p. i). There is a debate about exactly which STEM workers may be needed; however, the consensus is that there continues to be a need for STEM workers if the U.S. is to remain globally competitive (Angle et al., 2016; Stevenson, 2014; Xue & Larson, 2015). The call for STEM education endures today. According to Bruce-Davis et al. there is a "belief that American productivity in [STEM] fields is tantamount to the nation's long-term viability" (2014, p. 274). Moreover, Backes et al. (2018) suggest that "A growing number of policymakers argue that for the United States to remain a worldwide economic and technological leader, it must do more to improve the quality of K-12 science, technology, engineering, and mathematics (STEM) education" (p. 184).

Answering the call: Federal and state policy support for STEM programs. During the past 10 years, federal, state, and local support for and investments in STEM education has skyrocketed. In 2009, in response to the deficient performance of students on mathematics and science exams, President Barack Obama expressed his firm support for STEM education (President's Council of Advisors on Science and Technology, 2012). President Obama (State of the Union 2013: President Obama's address to Congress, 2013) also issued a call to action to improve STEM education and formed a STEM Coalition made up of business and educational advocates. The Coalition produced a campaign of ongoing "events to: (1) improve educational outcomes, (2) inspire students to pursue STEM careers, (3) improve hands-on laboratory environments, and (4) raise student, parent, and public awareness of the importance of science and technology to our nation's future" (Angle et al., 2016, p. 43).

The Carnegie Foundation (2011), in its report *Growing Opportunity*, issued an update on four goals for STEM education identified in 2009 to address the shortage of STEM talent and the need for all adults to be STEM-capable, regardless of their aspiration to work in STEM fields or not. It proposed a broad change in U.S. education with four primary recommendations: (a) require all students to take additional mathematics and science courses; (b) institute common, rigorous standards aligned with assessments; (c) support improved teaching and professional development; and (d) improve instructional models for teaching mathematics and science. The report suggests that "significant progress has been made in each area—enough to suggest that a movement has started that will produce real improvements in STEM education in the United States" (p. 4). However, the authors renew the call to action for making excellence and equity the cornerstones of the STEM education movement in the U.S.

The U.S. government answered that call by committing $3.7 billion of the U.S. federal budget to STEM education in 2011. This commitment continues today. Feller (2011) submits that the need for skilled STEM workers and national economic and business interests has produced a trend in which spending on STEM education and career training has multiplied and must continue to do so. In 2018, President Donald Trump held the first-ever State-Federal STEM Education summit to support the development of the federal five-year STEM Education Strategic Plan (White House Office of Science and Technology Policy, 2018).

A History of STEM Education in the U.S.

Historically, the U.S. began creating STEM-like programs in 1802, with the establishment of West Point, and then during the 1870s when mathematics and engineering students were taught using manual training methods, designed by professor Calvin Woodward, employing the mantra "technological literacy for all" (Sanders, 2009, p. 24). Woodward was able to combine the sciences, mathematics, and the technology of the time along with other academic areas to advance a philosophy in which the ideology developed. Following the successful launch of Sputnik by the Russians in 1957, the U.S. turned its educational focus toward science and mathematics for the development of technologies along with the evolution of engineering programs (Gubbins et al., 2013; Sanders, 2009). In the post-Cold War era, bipartisan support for STEM education grew at the federal and state level. This support was due to the belief that the nation's long-term economic viability was at stake (Bruce-Davis et al., 2014).

Eventually, many schools evolved that specialized in STEM arenas. Colleges and universities with strong science and mathematics programs attracted the nation's best and brightest to become engineers evolving into pioneers within the STEM fields. At the same time, education at the elementary and secondary levels changed and evolved to meet the needs of the nation's future. Over the past two decades, "an opportunity for technology educators to develop and implement new integrative approaches to STEM education [was] championed by [the] STEM education reform doctrine" (Sanders, 2009, p. 24). Despite these efforts, Change the Equation (2015), a nonprofit, non-political association advocating for STEM literacy, reports that the U.S. still struggles to achieve STEM literacy.

Change the Equation (2015) suggests that student performance in science decreases from elementary to high school: 42% of U.S. fourth-grade students are proficient in science, while 20% of 12th-grade students are proficient. In addition, according to the 2015 PISA assessment, 15-year-old U.S. students continue to lag behind students from many other countries. The U.S. ranked 41st out of 70 countries in mathematics and 25th out of 70 countries in science (Jackson & Kiersz, 2016). Furthermore, data collected from STEM high schools demonstrate that they are not serving the needs of students who graduate and undertake STEM majors in college, especially students who are underrepresented, including women, Hispanics, African Americans, and economically disadvantaged students (Almarode, Subotnik, & Maie Lee, 2016). Change the Equation (2015) also suggests that STEM jobs will grow by 19% compared to non-STEM jobs that will grow by 12% during the next 10-year period.

Although STEM schools have existed for more than a century, proclamations made by the NSF regarding threats to the U.S. stronghold on the science and technology industry have propelled policymakers to double their efforts to ensure students are fully prepared to enter jobs in STEM (Erdogan & Stuessy, 2015b; NSF, 2018). As a result, to improve education across the country, and to increase access to high-quality education, more secondary programs have infused STEM education than ever before (Lynch, Peters Burton et al. 2017; Rothwell, 2013). The aim of these programs with a concentration in cybersecurity, information technology, engineering, scientific research, medical fields, and environmental sciences is to ensure that the U.S. remains competitive within the global economy (Hinojosa et al., 2017). Despite these efforts, the current research reiterates the notion that the U.S. still has much work to do to prepare to meet its STEM needs.

The struggle to teach STEM. The educational system in the U.S. has struggled to meet the demand for a STEM-educated populace. To begin with, there is no universal agreement on what constitutes STEM. In addition, at the national level, there is a lack of clarity on what comprises STEM education (Gerlach, 2012). Moreover, according to Kelly and Knowles (2016), in practice, STEM educators lack a cohesive understanding of STEM education in practice.

Mohr-Schroeder, Cavalcanti, and Blyman (2015) define STEM education as:

> An interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy. (p. 10)

Others support this definition. Greene (2019) indicates that STEM is inherently interdisciplinary. Chiu, Price, and Ovrahim (2015) suggest that “the basis of STEM education involves integration of these [STEM] subjects by breaking down the silos of discipline-independent teaching that students often encounter” (p. 3). Overall, the definition highlights the need for STEM programs to be comprehensive and offer an integrated approach to learning the four disciplines included in the acronym, STEM.

The ACT (2017) produced a report, *STEM Education in the U.S.: Where We Are and What We Can Do,* that highlights in its introductory sentence, “it’s difficult to admit, but the United States is a STEM-deficient nation” (p. 1). The ACT is the only college readiness test that includes science in its assessment of students. “According to the ACT data, not enough U.S. students are equipped for STEM opportunities—now or in the future” (ACT, 2017, p. 1). Dagley, Georgiopoulos, Reece, and Young (2016) report that colleges and universities state that students are entering college unprepared for the rigors associated with STEM programs and majors. The ACT reports that 78% of students did not meet standards to enter entry-level college courses in STEM subjects. Gubbins et al. (2013) surmised in their study that students require resources that will provide them the needed rigor and coursework to progress in STEM fields. According to Dagley et al. (2016), this issue is of primary concern because students entering college in STEM majors often leave STEM fields due to their weakness in higher-level mathematics coursework.

In addition to student readiness concerns, the Gubbins et al. (2013) highlighted the difficulty colleges experience hiring qualified teachers and paints a bleak picture of the nation’s readiness to educate students for STEM programs at the collegiate level leading to careers within the STEM field. The ACT’s 2017 report highlights in its findings that providing students with access and opportunities to high-quality instruction is jeopardized by our nation’s lack of high-quality STEM teachers and the lack of academically challenging curriculum.

Teachers’ role in STEM education. Researchers have identified several shortcomings in today’s STEM classrooms, beginning with teachers lacking in their understanding of what it is to think like a scientist or an engineer (Gubbins et al., 2013; Education Scotland, 2017; Weiman, 2012). According to these researchers, teachers typically lack many of the requisites needed to design lessons with specific learning tasks that require students to think as scientists and engineers would. “Furthermore, their lack of content mastery, combined with a lack of pedagogical content knowledge, prevents them from properly evaluating and guiding the students’ thinking” (Weiman, 2012, p. 14). Additionally, Weiman (2012) believes teachers spend too much time in class with students engaged in passive activities such as listening and using specific methods to practice new skills. Neither of these strategies consists of the required cognitive components “nor require the level of strenuousness that are important in learning” (p. 14). Toulmin and Groome (2007) opine there is a lack of highly qualified STEM teachers and identify the quality of teachers attracted into the teaching profession and retained in schools as a significant problem. They cite a 2006 study by the Illinois Education Research Council providing evidence that merely raising mathematics standards will not increase student achievement. The study found that while more students were enrolled in mathematics courses considered to be advanced, underqualified teachers undercut student progress (Toulmin & Groome, 2007).

Contemporary needs of students in STEM classrooms. The STEM classroom needs teachers that can meet the needs of students by providing lessons that are differentiated to meet their needs while providing rigor and relevance along with practical applications to real-life (Gubbins et al., 2013; LaForce et al., 2016; NRC, 2014; Toulmin & Groome, 2007; Weiman, 2012). Weiman (2012) postulates that most teachers fall short in these aspects, which may be detrimental factors affecting the number of U.S. students not seeking STEM majors in colleges or for their careers.

Finding commonalities among successful STEM programs and schools and what makes them effective was the focus of a 2016 NSF-funded project. The study identified several elements in common among recognized successful STEM schools and deemed those elements as essential after interviewing school leaders and teachers at those schools. We deduced that each of the schools in their study had the following common characteristics: personalization of learning (differentiated instruction), problem-based learning, and rigorous and relevant learning (LaForce et al., 2016).

Differentiated or personalized instruction. The need to differentiate or personalize instruction is a common mantra employed among educational systems and classrooms. Researchers consider the need to personalize instruction as an essential element to maximize the impact teachers have on STEM students' success (Glancy & Moore, 2013; Perez, 2018; Woodland, 2014). "Personalization of learning takes the classroom away from a 'one-size-fits-all' strategy to allow for truly individualized instruction" (LaForce et al., 2016, p. 7). Targeting students' learning needs, thinking while building upon their prior knowledge, and recognizing possible cognitive challenges lead to the personalization of instruction (Weiman, 2012). Moreover, teachers should be provided with professional development to enhance their pedagogical repertoire and positively impact student learning on an individualized basis (Perez, 2018).

Problem-based learning. Problem-based learning involves having students work on projects that require interdisciplinary skills to solve and master content and stress the ability to apply learning to real-life situations (LaForce et al., 2016). Toulmin and Groome (2007) advocate the need to shift instruction from rote learning practices and activities toward a problem-based instructional format. They recommend incorporating questioning and investigative activities in the classroom to engage and challenge students. The National Governor's Association identified specific transferable skills required of all students for success in the STEM disciplines: "Using critical thinking to recognize a problem; using math, science, technology, and engineering concepts to evaluate a problem; and correctly identifying the steps needed to solve a problem" (Thomasian, 2011, p. 12). How would this investigative practice or problem-based learning take place? Problem-based or investigative learning requires the ability to develop an interdisciplinary approach to STEM education. Forcing students to think critically, employ information studied, and apply knowledge to solve problems is the essence of problem-based or investigative learning (Weiman, 2012).

Rigor and relevance. One proven strategy for improving student achievement outcomes at STEM high schools with high concentrations of minorities is to increase the academic rigor by providing advanced academic classes and high-quality Project Based Learning ([PBL] Edmunds, Arshavsky, Glennie, Charles, & Rice, 2017). Rigorous learning "focuses on [the] content and process that are challenging for the students and call for high cognitive demand" (LaForce et al., 2016, p. 7). Students in mathematics classrooms often ask, "When am I ever going to use this?" Providing students with the relevance they crave and require is the answer to this question. The teacher who can consistently show the connection between concepts being taught, by providing students with real-world applications, will afford students the relevance they need (Matthews, 2018). The National Governor's Association report identified the lack of connecting classwork with real-world problems and applications as a substantial issue in STEM classrooms, resulting in a significant lack of relevance for students (Thomasian, 2011). Challenging coursework that engages students is essential to incorporate new knowledge and skills that may be applied to real-world situations. When teachers provide students with intensive problem-based lessons, the rigor and relevance of instruction are enhanced (Blackburn, 2018).

Magnet Programs

History. The civil rights movement of the 1960s was the catalyst for the creation of magnet schools, which sought progressive reform and integration of students from different racial backgrounds. Curtailing the continuous cycle of academic discrepancies evident in minority and economically disadvantaged student populations has been a focal point of proponents of educational equity since the 1954 ruling on the landmark Supreme Court case *Brown v. Board of Education*. The unanimous ruling, in this case, sought to voluntarily integrate schools in the U.S. under the Equal Protection Clause of the Fourteenth Amendment to the U.S. Constitution (*Brown v. Board of Education*, 1954). During the 1960s, magnet schools were conceived to create reform and integrate students from different socioeconomic backgrounds. Essentially, school systems created "programs with special themes and emphases…to promote racial integration" (Institute on Metropolitan Opportunity, 2013, p. 1) and to support equity and equality for all students. Districts hoped that these programs would create "voluntary racially integrated schools" (p. 1).

Federal government funding aimed at desegregating schools and increasing parental choice provided magnet schools with a period of unprecedented growth in the U.S. during the 1960s and 1970s (Orfield et al., 2008). "Congressional support for desegregation first came in the form of the Emergency School Aid Act" in 1972 to "encourage the voluntary reduction, elimination, or prevention of minority-group isolation" (USDOE, 2003, p. v). The U.S. government began supporting this effort financially in 1977 through an amendment to Emergency School Aid Act and then in 1984 by creating the Magnet Schools Assistance Program. By 1985, the federal Magnet Schools Assistance Program, authorized by the U.S. Congress, provided grant funding to magnet schools to desegregate public schools. Magnet schools evolved from the early movement of themed education into the innovative programs offered today to eliminate the achievement gaps between minorities (Magnet Schools of America, n.d.).

The Magnet Schools Assistance Program (Federal Register, 2016) funds magnet programs based on five overarching goals:

1. The programs must decrease or eliminate minority group isolation in elementary and secondary schools with large numbers of minority students.
2. They must support systemic reforms and allow all students to work with challenging academic content.
3. They must include innovative practices that promote diversity and increase choices for students.
4. They must build capacity in the schools through professional development.
5. Finally, they must strengthen students' knowledge of academic subjects and marketable career and technical education.

Despite these different goals, the Magnet Schools Assistance Program's primary goal for magnet schools is desegregating schools. In summary, magnet programs aim to reduce, eliminate, and prevent minority group isolation by integrating diverse student populations to narrow and close the achievement gap (Federal Register, 2016). Waldrip (2011) opines that "Magnet schools are still used to reduce racial isolation, but they are more and more considered superior options within the public sector for all students, even in districts of primarily one race" (para 16).

Chen (2019) describes magnet schools more simply as schools that have three distinctive features. They have a unique curriculum or instructional approach; they admit students from outside the school's attendance boundaries, and they explicitly seek to have a diverse student body. Interestingly, school choice in the U.S. has existed for as long as schools have existed. Parents with financial means could choose parochial schools, private tutoring, private schools, or even boarding schools for their children (Carpenter & Kafer, 2012). However, because they are free public schools, magnet schools made choice available to all parents, regardless of income.

While not the topic of this paper, charter schools also increase school choice options for students and their parents. Public school choice via charter and magnet schools continues to be popular in school districts in the U.S. According to data from the National Center for Education Statistics (n.d.), 2014-15 magnet programs enrolled approximately the same number of students served by charter schools, with more than 2.5 million students in the U.S. attending magnet schools. Currently, there are 4,340 magnet schools, of which 31% are high schools, serving more than 3.5 million students (Magnet Schools of America, n.d.). This 40% increase in enrollment illustrates the momentum that magnet schools have gained. Thus, this highlights the need to measure the effect of magnet schools on student academic achievement.

The funding priorities of Magnet Schools Assistance Program remain the same, yet the expansion of school choice has affected the implementation of magnet schools (Frankenberg & Siegel-Hawley, 2008). Typically, magnet school growth is funded using federal dollars. However, some districts, such as M-DCPS, supplement magnet funding with district funds. As a result, magnet programs may have shifted away from the focus on desegregating school districts (Institute on Metropolitan Opportunity, 2013).

Equity and access. Although outside the scope of this research, it is essential to note that equity and access are foundational to the concept of magnet schools. Equity is not a product but a process of building culture over time (Powell, 2015). The concept of equity assumes that educators understand that there are barriers that prevent students from accessing the curriculum. Assurances of access to challenging academic opportunities for all students would require schools to eliminate racial segregation. These rights were embedded in The Fourteenth Amendment under the Equal Protection Clause, although education was not explicitly addressed and left to each state's purview.

According to Darling-Hammond (2010), current educational policy attempts to make reparations for the lack of diversity in our classrooms. All students need to be educated to compete in a global marketplace. Ensuring that school systems implement equitable practices is a vital component of closing opportunity gaps. Boykin and Noguera (2011) suggest that race and class are strong predictors of student achievement, and minority students living in generational poverty tend to achieve at lower levels. Unfortunately, research indicates that poor educational outcomes are a byproduct of resource inaccessibility among different populations of students (Darling-Hammond, 2010).

The U.S. fails to invest in the intellectual development of its children. This marks one of the most significant missed opportunities in providing children with the equity and access necessary for future upward mobility (Finn & Northern, 2018). Unfortunately, it is also not a new phenomenon. The 1954 landmark U.S. Supreme Court case *Brown v.*

Board of Education was viewed as an opportunity to correct some racial inequities in the U.S. educational system. Regrettably, however, Darling-Hammond (2010) makes a statement about assumptions of school integration after this case: "By 1964, fully a decade later, 98% of African American students in southern schools were still enrolled in all Black schools" (p. 35). By the 1970s, unequal schooling for Black and Hispanic students had not changed much; 30 years after federal mandates to desegregate, schools continue to have homogenous minority populations (Darling-Hammond, 2010). Currently, the conceptual adaptation of desegregation efforts to increase access for students refers to the reduction of minority group isolation. Ultimately, minority students, when learning among diverse groups of students, develop skill sets, strategic thinking, and complex reasoning, thus setting the foundation for demonstrating improved student achievement (Konan, Chatard, Selimbegovic, & Gabriel, 2010).

Magnet schools were developed as a strategy to desegregate schools (Rossell, 2005). These efforts were a precursor to the goal of reducing minority group isolation (USDOE, 2003). Desegregation efforts are successful when magnet programs accept students based on interest in curricular programs rather than established criteria (USDOE, 2018). Unfortunately, many magnet programs have prerequisites that filter students by academic ability with course requirements in mathematics, science, or minimum GPA standards, and therefore, do not address the goal of decreasing minority group isolation. This practice undermines the tenets of equity and access. While many magnet programs in M-DCPS follow the selective model, the district understands the importance of equity and access and takes deliberate action to reduce minority group isolation (M-DCPS, 2018b). During its magnet school student recruitment process, M-DCPS targets students from identified zip codes that have historically been under-represented for enrollment into magnet schools (M-DCPS, 2017).

Models. There are two commonly used instructional models for magnet schools. A school may operate as a Whole School Magnet. The Whole School Magnet model offers a magnet curriculum to all students within the school. A second model operates as a magnet Program Within a School, offering the magnet curriculum to selected students within a school (USDOE, 2003). Magnet schools and programs within a school also offer many different themes and emphases. They may emphasize a particular academic discipline, such as STEM or the arts; an instructional model, such as open schools, academies, or multi-grade classrooms; or a specific instructional approach, such as Montessori, Cambridge, or International Baccalaureate (Magnet Schools of America, n.d.). All of the schools in this study operate using the Program Within a School model.

Magnet school impact. Magnet Schools of America (n.d.) reports that magnet schools demonstrate higher graduation rates, have lower teacher turnover rates, report higher mathematics test scores, and have a more diverse student population than non-magnet schools. Meanwhile, research examining whether magnet schools improve academic performance has produced mixed results, with some studies finding that magnet students have higher levels of achievement and other studies finding comparable performance between magnet and non-magnet students (Betts, Rice, Zau, Tang, & Koedel, 2006: Blazer, 2012; Institute on Metropolitan Opportunity, 2013).

Some of the earliest research on the academic achievement of magnet schools demonstrates that these programs have a positive impact on student achievement (Ballou, Goldring & Liu, 2006; Gamoran, 1996; Siegel-Hawley & Frankenberg, 2011; Wang, Herman & Dockterman, 2018). Other studies support the notion that students' success can be attributed to the type of school attended (Betts et al., 2006; Bifulco, Cobb & Bell, 2009). Engberg, Epple, Imbrogno, Sieg, and Zimmer (2014) studied the effectiveness of magnet programs in an urban district. Their interest was in oversubscribed magnet programs that use lottery-based admissions. Engberg et al. (2014) found that magnet schools have positive effects; however, they cautioned that the study's sample sizes were too small to provide exact estimates. Betts, Kitmitto, Levin, Bos, and Eaton (2015) studied 21 Magnet Schools Assistance Program supported elementary schools that converted from traditional schools to magnet schools. Betts et al. (2015) found that language arts achievement increased in the schools that converted to magnet schools compared to the traditional schools that did not convert.

By contrast, in a longitudinal study conducted in one of the nation's largest districts, data were examined from more than 100 magnet schools, including more than 400,000 students, across seven school years from 2007 through 2014. The researchers examined student achievement by looking for improvements in mathematics and reading scores on standardized tests. The results of the study provided little evidence of student achievement benefits from magnet schools (Harris, 2019). Programs Within a School seem to be the most beneficial magnet type, with evidence of achievement gains in both reading and mathematics. Our study approached student achievement in a different way than Harris' study. We measured achievement using graduation rates, GPA, and the number of mathematics and science courses completed.

STEM Magnet Programs

Magnet and STEM combinations. According to the National Center of Education Statistics (n.d.), the number and student population of magnet schools more than doubled from 2000 to 2016. As the number of magnet programs increased nationally, the themes and curricular focus of these programs also expanded. STEM programs are among the fastest-growing magnet school programs; currently, approximately 30% of all magnet programs are STEM programs (Magnet Schools of America, n.d.). National data indicate that only 25% of 12th graders achieved a level of proficient or higher on the 2015 NAEP mathematics assessment, and 22% achieved a level of proficient or higher on the 2015 NAEP science assessment (NSF, 2018). Unfortunately, although STEM programs have expanded rapidly, results have been mixed on their effectiveness as it relates to student academic performance.

The promise of STEM schools. Some researchers suggest that STEM magnet school programs have positive effects. STEM magnet school programs increase test scores, especially for underrepresented students (Young, House, Wang, Singleton, & Klopfenstein, 2011; Scott, 2012). Additionally, STEM magnet school programs increase self-efficacy in mathematics and science and increase minority representation (Sublett & Plasman, 2017; Scott, 2012).

Increased test scores, especially for underrepresented students. In 2006, Texas began to collect data on students underrepresented as minorities in STEM high schools and found significant patterns of higher test scores among these demographic categories but not in the overall comparisons to general populations of students in a STEM program (Young et al., 2011). Students in STEM-focused schools were provided an array of

STEM content in core subjects and elective classes, and they outperformed students who attended traditional schools in English and mathematics on statewide testing (Scott, 2012). The average performance was 13% higher in English and 12.78% higher in mathematics. The results suggest that STEM-focused schools may have an advantage to traditional schools in equipping students with the skills necessary to compete in a 21st-century technological economy.

Recent case studies also have provided compelling data in support of STEM schools. With the emergence of STEM programs across the U.S., Lynch, Spillane et al. (2017) conducted a case study of Manor New Tech High. The school had received national acclaim as a successful STEM school and was the setting for President Barack Obama’s 2010 speech on U.S. STEM education needs. The study revealed that standardized test scores of incoming Manor New Tech High and Manor Independent School District 8th graders were comparable on the English Language Arts and Mathematics portion of the Texas Assessment of Knowledge and Skills (TAKS). However, scores on Science and Social Studies portions of the exam showed slightly higher scores for incoming Manor New Tech High students.

Nevertheless, by 11th grade, the Manor New Tech High students had a significantly higher percentage of students meeting standards on all test areas measured by the TAKS (Lynch, Spillane et al., 2017). Additionally, graduates’ enrollment rates in post-secondary institutions were noticeably above the national average. These promising results suggest that STEM programs may be fulfilling their promise of increasing student achievement and better preparing students to enter post-secondary programs.

Increased mathematics and science self-efficacy. Incorporating STEM programs in a high school's curriculum represents a method to meet the demand of producing college and career-ready high school students (Sublett & Plasman, 2017). In their study, Sublett and Plasman (2017) used nationally representative data to investigate the impact that participating in STEM coursework had on predicting the mathematics and science self-efficacy of high school students. The study was conducted under the premise that by increasing a student's mathematics and science self-efficacy, student achievement would increase, and interest in STEM subjects would grow to fill STEM-related jobs. Sublett and Plasman (2017) concluded that earning credits in applied STEM courses, which have a focus on career and technical education (CTE), increases mathematics and science self-efficacy in high school students. The research found that one could expect levels of self-efficacy in mathematics to increase by an average of 0.04 standard deviation units for each additional applied STEM credit earned by a student. Similarly, one could expect science self-efficacy to increase by 0.03 standard deviation units for each additional STEM credit earned. This potential pipeline of STEM-capable students crafts a narrative and argument in support of STEM-focused schools.

Representation of minorities in STEM programs. Scott (2012) examined the characteristics of 10 STEM-focused high schools from different regions of the U.S. In her study, Scott examined the type of courses offered, population served, student performance on high-stakes exams, the school's vision statement, entrance criteria, and type of academic program offered at the STEM-focused schools. One interesting finding was that STEM schools served a higher percentage of minority students than the national average. The percentage of Black students attending STEM schools was 34% higher than the percentage of Black students enrolled in U.S. public schools. This finding is thought-provoking because it suggests that STEM magnet schools may be achieving success in serving the needs of underrepresented students and fulfilling the initial intent of establishing magnet schools to integrate K-12 education.

Falling short of the promise. In contrast to research supporting STEM schools, some researchers suggest that U.S. STEM schools do not produce better results than non-STEM schools (Blazer, 2012; Marshall, 2010). One of the arguments details the shortcomings of the models and the delivery of instruction as factors (Marshall, 2010; LaForce et al., 2016). The relatively small effect size in research studies is another point of contention (Erdogan & Stuessy, 2015a; Sublett & Plasman, 2017).

Programming concerns. Marshall (2010) opines that STEM schools have an inherent fault in their model and delivery of instruction. He argues that the current design of STEM schools does not challenge students to be independent and creative thinkers. As such, he suggests that this form of education does not meet the demands of a global and technological economy that is seeking divergent thinkers. Marshall (2010) suggests that educators need to redesign specialized STEM schools to prepare self-directed, adaptive, and reflective thinkers who can meet the demands of a globally competitive economy. Marshall explores a conceptual learning design rooted in nine core principles, yet he provides no empirical evidence to support his vision for the 21st Century STEM school. This lack of empirical data reveals the need to further study the impact of STEM magnet schools on student achievement.

One major challenge is the variability in programming and the curriculum design of STEM education. STEM curriculum does not have a blueprint; therefore, administrators are required to plan, design curriculum, and sustain these thematic programs. The variation in design and instructional delivery has created a disparity among programs in schools (M-DCPS, 2015). LaForce et al. (2016) suggest that STEM schools focus heavily on problem-based learning, interdisciplinary instruction, mastery learning, and real-world problem-solving. Moreover, the teachers develop their curriculum without pedagogical expertise. He argues that these schools focus more on creating an environment that incorporates these strategies rather than precisely delivering STEM content. Unfortunately, LaForce et al. (2016) further suggest that student achievement decreases rather than increases in these schools.

The results of a study of six inclusive STEM high schools in Ohio support the ideas of Marshall (2010) and LaForce et al. (2016). The study estimated the impact of STEM education on student achievement. In general, the schools had a negligible effect on student achievement in STEM and non-STEM courses (Gnagey & Lavertu, 2016). The authors suggest that the results of the study are consistent with the idea that inclusive STEM schools focus more on personalized instruction rather than on content.

Marshall's (2010) and LaForce et al.'s (2016) arguments may relate to the lack of consensus on what STEM education should look like in the U.S. Furthermore, these arguments lead to questions regarding the effectiveness of magnet schools in preparing a STEM-capable workforce to meet industry demands (NRC, 2011). While not looking at workforce development, our study provides valuable information regarding magnet STEM students' level of readiness to enter college STEM programs that may prepare them for the STEM workforce.

Our study did not explicitly address the delivery model in STEM classrooms. However, we acknowledge the disparity that exists between creating the appropriate learning environment and ensuring the delivery of STEM content. As such, a component of our study asked teachers to report the frequency with which they implemented STEM activities as part of their instructional delivery. I The results of a t-test for independent means indicated that magnet teachers utilized, on average, a slightly higher number of STEM instructional strategies non-magnet teachers but the difference was not statistically significant.

Low effect size in existing research findings. With the rising demand for a STEM-capable workforce and the identified shortfall in the U.S. of workers with STEM knowledge, the absence of consensus on the effectiveness of magnet STEM schools adds complexity to determining whether these specialized schools are a viable option to meet the demands that threaten our national economy (NRC, 2011). When comparing TAKS scores of 11th-grade students attending STEM schools or traditional schools, there was no statistical difference in reading, mathematics, and science scores (Erdogan & Stuessy, 2015a). Although students in STEM magnet programs demonstrated slightly higher scores in reading, mathematics, and science, differences between mean scores were not significant, and the effect size was relatively small, ranging from 0.020 to 0.128 (Erdogan & Stuessy, 2015a).

In an earlier study also conducted in Texas, Young et al. (2011) looked at the achievement of high school students in inclusive STEM schools and compared the results to the achievement of students in traditional schools. The researchers found that ninth- and 10th-grade students attending inclusive STEM high schools performed better on mathematics assessments than students attending traditional high schools. However, the effect sizes were low, suggesting the differences were small.

Studies comparing demographic variables such as gender, ethnicity, socioeconomic status, and special education have also been conducted to measure the effectiveness of magnet STEM programs. While they revealed statistically significant differences between Hispanic and White students in traditional and STEM schools for reading, mathematics, and science, the effect size for both subgroups was small, ranging from 0.022 to 0.117 (Erdogan & Stuessy, 2015a). Nevertheless, results accounting for socioeconomic status also demonstrated a statistically significant difference between Hispanic and White students in traditional and STEM schools for reading, mathematics, and science (Erdogan & Stuessy, 2015a). Furthermore, the struggle to definitively affirm the effect magnet STEM programs have on student performance remains with research showing the effect size for economically disadvantaged students comparatively small, ranging from 0.044 to 0.105 (Erdogan & Stuessy, 2015a).

Other findings**.** In 2013, North Carolina conducted a value-added study of schools with STEM programs, and there was no difference found among test scores of students in STEM programs compared to students in comprehensive high school programs (Hansen, 2014). Sublett and Plasman (2017) further suggest that research has not revealed any statistically significant levels of increase in mathematics and science self-efficacy for female students or students with disabilities who earn credits in applied STEM subjects. It is also important to note that neither poverty nor high rates of minority student demographics are variables directly related to this study. However, studies demonstrate that high poverty directly affects graduation rates (Morgan, Sinatra, & Eschenauer, 2015).

STEM programs in Miami-Dade County Public Schools. In South Florida, M-DCPS has adopted a variation of all three NRC models of STEM-focused schools: Selective, Inclusive, and STEM career and focused technical programs (NRC, 2011). For more than 40 years, school choice has been at the forefront in M-DCPS and has produced an array of innovative STEM magnet programs. These STEM programs have broadened choice options for students and parents (M-DCPS, 2015). Furthermore, STEM magnet program strands have expanded gradually into traditional schools to increase accessibility to local communities.

With federal monies flowing into states and school districts, STEM programs have blossomed into every community within M-DCPS. Approximately one-third of M-DCPS high school students (37,000 of 109,000) attend a magnet program (M-DCPS, 2019a). Of those, 9,250, or approximately 25%, attend a STEM magnet program. Many schools have added magnet programs in recent years, and many of the magnet programs have been STEM programs. Some of these schools serve as stand-alone full STEM magnet programs, but many of the schools established STEM magnet programs within their schools, and other schools offer STEM courses that are not part of magnet programs.

The success of STEM education in the U.S. is a challenge due to the deep-rooted variables that contribute to the student achievement gap. In a community as diverse as Miami-Dade County, the charge to narrow academic achievement gaps and prepare students for the demands of STEM careers and 21st-century skills is a constant struggle.

Fortunately, M-DCPS has received numerous federal grants and state funding to establish STEM magnet programs throughout the school district, including the Magnet Schools Assistance Program federal grant to support STEM education, totaling more than $45 million since 2006. The primary focus of these grants has been the establishment of STEM magnet programs throughout the district's most underserved and underrepresented populations. Specifically, during the 2013-16 magnet funding cycle, M-DCPS received $10,704,209 to develop whole school STEM magnets in two schools. During the 2017-20 funding cycle, M-DCPS received $15 million to develop STEM magnet programs in three schools. In addition to the funding provided through federal ,, the district, in alignment with its priority to provide choice to students, continues to commit a great deal of funding to magnet schools. These funding figures do not account for M-DCPS' in-kind contributions of facilities, existing resources, and matching district funds for upgrades of school infrastructures. According to M-DCPS' (2016) *Executive Summary, Tentative Budget for Fiscal Year Ending June 30, 2017*, the financial outlay M-DCPS allocated to magnet programs exceeded $25 million and served more than 35,000 students in its magnet programs. Of the students in magnet programs, 25% attended STEM magnet programs.

During the last 10 years, M-DCPS has been aggressive in creating a magnet school brand image, especially STEM-themed magnet programs countywide, resulting in considerably increased exposure of STEM magnet schools. With this improved publicity and a reduction in student enrollment at traditional schools in the urban core, the concepts of access and equity have appeared once again as a critical driver to policy decisions. As such, the conversations about access, fairness, and transparency have led to questions regarding the effect of STEM magnet schools on student achievement. With STEM programs multiplying across the county, the most pressing question to ask is whether the return on investment is substantiated. This study of high school STEM magnet schools seeks to understand the impact of these magnet programs on student achievement.

Summary

Global competition has placed a tremendous amount of pressure on schools, particularly secondary schools, to produce students who can meet the growing demand for a STEM-savvy workforce needed to remain competitive in a technologically driven global economy. As a result, schools have scrambled to create programs that meet this rising market demand (Angle et al., 2016). The U.S. government has also played a role in providing funding to support the efforts of growing this STEM-savvy workforce. Most recently, the U.S. government's efforts resulted in the development of a five-year STEM Education Strategic Plan (White House Office of Science and Technology Policy, 2018).

STEM is not a new concept. Although not referred to as STEM, the need for education in the field of science has been prevalent for more than a century. However, challenges in defining STEM has created disagreement at the federal and state levels regarding what constitutes STEM education (Gerlach, 2012; Kelly & Knowles, 2016). This lack of clarity has permeated into today's STEM classrooms and is manifested as teachers' disagreement on what STEM instruction should look like and how content should be delivered. This study aims to provide more clarity by examining the effects of STEM education on student achievement.

Magnet programs were formed to assist with the desegregation of schools by developing equitable environments where minority students had access to quality to education (Orfield et al., 2008). The federal government began to provide funding for magnet programs in the 1970s and in 1984 created the Magnet Schools Assistance Program . Currently, the two most prevalent magnet school program models are the whole school magnet and the program within a school (USDOE, 2003). Research on the impact of magnet schools indicates mixed results on their effectiveness on student achievement.

However, investment in magnet programs continues to increase. Among magnet programs, STEM magnet programs are the fastest growing (Magnet Schools of America, n.d.). STEM magnet programs have not been impervious to the disagreement that has plagued STEM education. Similar to magnet schools, STEM magnet programs have also experienced mixed results on their impact on student achievement (Blazer, 2012; Erdogan & Stuessy, 2015a; Gnagey & Lavertu, 2016; LaForce et al., 2016; Lynch, Spillaneet al., 2017; Marshall, 2010; Scott, 2012; Sublett & Plasman, 2017; Young et al., 2011).

These mixed findings further reiterate the need to study the effectiveness of magnet STEM programs on student achievement in M-DCPS. Is M-DCPS' $45-million investment in STEM education since 2004 improving student achievement? Like many of the previous studies, our study had mixed findings. As a result, we provide recommendations based on our findings to support the continued investment in these programs with modifications.

CHAPTER 3

METHODS

This chapter describes the methods that were utilized to conduct the study and outlines the research methodology, participants, method of sampling, procedures, data analysis, limitations to the methodology, and threats to credibility. This study used an explanatory mixed-methods approach. According to Creswell (2014), "Mixed methods research is an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks" (p. 4)." Essentially, a study using mixed methods provides "a more complete understanding of a research problem than either approach alone" (Creswell, 2014, p. 4)."

Using the mixed methods approach, we studied the effect of STEM magnet education on academic achievement by analyzing graduation rates, GPA, and mathematics and science course completion by students from selected high schools. Selected schools are M-DCPS attendance boundary high schools that offered a STEM magnet program within the school that have minimally six years of data. Whole school magnet programs were excluded from the study because they did not have any non-magnet students. We also employed a survey to gain STEM teachers' perceptions of their efficacy, outcome expectancy, and stem instructional activities, and administrators' perceptions of their leadership of the STEM programs in their programs outperform non-magnet students meeting eligibility criteria programs for STEM magnet participation.

The explanatory sequential mixed methods research design provided researchers with a comprehensive analysis of the problem by merging quantitative and qualitative data (Creswell, 2014). Creswell (2014) states that in this approach, “a researcher first conducts quantitative research, analyzes the results, and then builds on the results to explain them in more detail with qualitative research” (p. 15). Because of the multi-faceted context surrounding magnet STEM programs, we expected that this approach would provide detail and information to clarify the results of the quantitative portion of the study. The synergy created by integrating both qualitative and quantitative data provided answers to questions that otherwise may have been difficult to answer by using a single method (Tashakkori & Teddlie, 2010).

Participants

M-DCPS is the fourth-largest public-school system in the U.S., with a total enrollment of 350,040 students (M-DCPS, 2019a). The district has 342 schools, of which 54 are high schools (M-DCPS, 2019a). Most of the high schools offer some type of magnet program; 38 high schools offer STEM magnet programs (M-DCPS, 2015). A few of the STEM magnet programs are whole school magnet programs; that is, all students in the school participate in the magnet program. Most, however, are programs within a school, where a selected number of students participate in a magnet program. We excluded whole school magnet programs and identified high schools within the target school district that had a STEM-themed magnet program within the school for at least six years. We excluded whole school magnet programs because there would not be a comparison group within the school. This strategy allowed us to collect data for three graduating Cohort years: 2011-12, 2012-13, and 2013-14. A review of the data demonstrated that 12 schools qualified for this study. Data from all 12 schools were used. It is interesting to note that there was variability in the types of programs offered by the schools and in the percentage of students participating in the STEM magnet programs among the selected schools. Additionally, we determined that 2,081 students met the magnet eligibility criteria but did not participate in the STEM programs during the study period. This group provides a similarly qualified set of students to compare to those who did participate in a STEM magnet program. See Table 1 for a list of study schools, current demographics, and the number of instructional periods offered by each school.

There were three types of participants for this study: students, teachers, and administrators. Each group is briefly discussed below.

Students. Participating students were comprised of Cohorts 1, 2, and 3 of the selected schools. Students enrolled in the STEM magnet programs at the subject schools formed the target group. Attendance boundaries determined the students enrolled in the traditional school program. As such, there were no entrance criteria for student admittance to the school. Students in a STEM magnet program, however, had an entrance requirement of successfully completing Honors Algebra I and Honors Earth Space Science (Cohort 1) or Honors Physical Science (Cohort 2 and 3) in eighth grade. Therefore, the same criteria were used to identify a comparison group of students in the traditional programs within the 12 selected schools. We compared the data from the target and comparison groups.

Table 1

Subject Schools and Demographics during 2018-2019 School Year

School	STEM Program	Students in STEM Program	Total Enrollment	STEM Teachers	Class Periods/ Day
A	International Business & Finance, Health Science, Allied Health Science	223	2,364	27	6
B	Information Technology	494	3,088	37	6
C	IT, International Business & Finance, Medical Skills/Biomedical	2,678	4,187	59	8
D	IT, Engineering and Robotics, Global Trade and Statistics, Architecture	433	1,553	38	8
E	Architecture, Construction, Engineering, Robotics, Biomedical	350	2,480	30	6
F	Finance and First Responder	81	735	15	8
G	International Business and Finance	143	1,453	30	8
H	iPrep	105	1,602	17	6
I	Forensic Investigative Academy, AP Capstone, iPrep, iTech, Cyber Security, Engineering, Allied Medical Sciences, Pre-Med, Sports Medicine	368	2,711	38	6
J	Banking and Finance	178	2,412	33	6
K	International Business and Finance, Health Science & Allied Health Science	212	1,550	23	8
L	Engineering, Business and Finance, Health Sciences (Nursing/First Responder)	181	1,432	22	8

Note. The names of the schools have been masked intentionally. The number of Science, Technology, Engineering, and Math (STEM) teachers per school consists of mathematics, science, and STEM program area teachers. IT = Instructional Technology, iPrep = academy integrating technology throughout the curriculum, AP = Advanced Placement, iTech = academy focusing on computer programming.

To determine the cohort of students for this study, we began with all students who entered one of the 12 study schools as ninth graders in the fall of the cohort year (Cohort 1: 2011-12, Cohort 2: 2012-13, Cohort 3: 2013-14). Then, students who did not meet the eligibility criteria for the random selection for magnet programs were eliminated from the cohort. From the remaining students, withdrawal codes were used to determine students who withdrew to a verified alternate school any time during the four years following the entry date and withdraw them from the cohort. The graduation rate was determined for the cohort after students who transferred to a verified alternate location were removed. Courses and GPA were calculated for graduates only. In the state of Florida, there are many approved withdrawal codes. For students in high school, these codes have implications for students' graduation status. In some cases, students count as non-graduates and are included in the calculations for graduation rate. In other cases, the students count as graduates and are included in the calculations for graduation rate. However, students who withdraw to a verified alternate school (in-county, in-state, out of state, private, or charter) are removed from the cohort and not included in graduation rate calculations (see Appendix A).

The total sample analyzed for graduation rate included 4,016 students. There were 1,271 students in Cohort 1; 1,282 students in Cohort 2; and 1,463 students in Cohort 3. The total number of graduates was 3,370, including 1,158 in Cohort 1; 1,150 in Cohort 2; and 1,422 in Cohort 3. These students' records were analyzed for GPA and the number of mathematics and science courses taken.

There are three- and four-year graduation options for students. Students selecting one of the three-year accelerated graduation options were excluded from this study because they have different course requirements for graduation and could have confused the courses taken data for this study.

Magnet to non-magnet. The population in this study included students meeting the magnet eligibility criteria from the 12 schools at the beginning of each cohort year. These students were categorized as magnet and non-magnet. Cohort 1 was comprised of 907 non-magnet students and 503 magnet students; Cohort 2 encompassed 772 non-magnet students and 707 magnet students; and Cohort 3 included 893 non-magnet students and 856 magnet students. However, after accounting for students who transferred to verified alternate school locations, the cohorts used for analysis were comprised as follows: Cohort 1 was comprised of 796 non-magnet students and 475 magnet students; Cohort 2 encompassed 614 non-magnet students and 668 magnet students; and Cohort 3 included 671 non-magnet students and 792 magnet students.

Between group comparisons. A review of the school bell schedules for the 12 schools identified six high schools with a six-period schedule and the other six with an eight-period schedule. See Table 1 for the number of periods offered at each subject school.

Teachers. All STEM teachers from the 12 schools, whether teaching in the magnet program or not, were invited to complete a survey. This survey allowed them the opportunity to provide their perspectives on their efficacy and beliefs, impact on student outcomes, and STEM instructional practices (see Appendix B).

Administrators. The principals and assistant principals of all 12 schools were invited to complete a survey. This survey provided principals and assistant principals the opportunity to share their perspectives on their leadership of the STEM programs in their schools (see Appendix C).

Data Sources

This study included two primary sources of data: student performance data and survey data. Student performance data, including graduation rates, GPA, and the number of mathematics and science courses completed, generated the quantitative data. A survey primarily provided quantitative data but had four open-ended questions that provided qualitative data that assisted us in gaining a richer and more comprehensive understanding of factors that contributed to or inhibited student success in STEM magnet programs. The student performance data and survey instruments are described below.

Student performance data. Student performance data included graduation rates, GPA, and the number of mathematics and science courses completed. GPA and the number of mathematics and science courses completed for all participants at the time of their graduation were used to compare the achievement of magnet STEM students to non-STEM students. Graduation rate, GPA, and course completion information were obtained from the M-DCPS' Office of Assessment, Research, and Data Analysis , and the Federal and State Compliance Office.

***Graduation rates*.** Miami-Dade County Public Schools provided cohort graduation data from each of the subject schools. The graduation cohort included all students entering one of the 12 schools as ninth graders in the fall of the first year of each cohort. For this study, the students who withdrew to other schools (in-county, out of county, out of state, private, charter, or out of the country) and those who did not meet the eligibility requirements for random selection to the STEM magnet were removed from the cohort. M-DCPS provided graduation codes for each student and a list of graduation codes that identify graduates, non-graduates, and students removed from graduation cohorts (see Appendix A).

The graduation rate was based on the number of students graduating within four years and a summer within their cohort membership. Each cohort was divided into two groups: students enrolled in the STEM magnet program in ninth grade and students who met the STEM magnet program entrance requirements but did not enroll in the STEM magnet program.

Graduation requirements. The graduation standards established by the State of Florida for a standard diploma require the "successful completion of 24 credits . . . earning a cumulative GPA of 2.0 on a 4.0 scale, and attaining passing scores on required statewide, standardized assessments or concordant scores" (M-DCPS, 2019b, p. 78). Table 2 provides an outline of graduation requirements for a Standard Diploma in Florida for students entering grade nine in 2011-2012, 2012-2013, and 2013-14 school year (Florida Department of Education, 2014).

Table 2

Standard Diploma Graduation Requirements in Florida

Course	Required Credits	Testing Requirements
English/Language Arts (ELA)	4	Grade 10 FCAT 2.0 / ELA Assessment*
Mathematics	4	Algebra I End-of-Course Assessment
Science	3	
Social Studies	3	
Fine and Performance Arts, Speech and Debate, or Practical Arts	1	
Physical Education	1	
Elective Courses	8	
Online Course	1	

Note. Students may substitute the ELA Assessment or Algebra I End-of-Course scores with a concordant score on an alternate assessment.
*Cohort 3 only

Changes in graduation requirements. In 2011, Florida State Statue 1003.41, Sunshine State Standards dictated that high school science standards must include specific curricular content for, at a minimum, the nature of science, earth and space science, physical science, and life science. As a result, the M-DCPS Office of Academics and Transformation changed the introductory science course for all ninth graders from Earth Space Science to Physical Science in the Student Progression Plan effective fall, 2012, to prepare students for Biology, Chemistry, and Physics. This course was also offered as an advanced course to eighth graders, effective 2012. This change impacted Cohorts 2 and 3 of this study.

The M-DCPS Student Progression Plan outlines the sequence of courses for middle school science as M/J Comprehensive Science 1, 2, and 3. The enhanced criteria for random selection for high school magnet programs, set forth by the M-DCPS Office of School Choice and Parental Options beginning in 2012, allowed schools to require that student(s) complete and receive credit for Physical Science Honors and Algebra I Honors prior to the start of the school year for which the student applied (M-DCPS, 2017).

Before 2013, Florida not only required four mathematics courses and three science courses for graduation but also required specific mathematics and science courses. However, Florida Senate Bill 1076 K-20 Education (2013) removed prior graduation requirements. Currently, students must successfully complete four mathematics courses. However, the only required mathematics course for graduation is Algebra I, including passing the related end-of-course exam or earning a concordant score on an approved alternate standardized mathematics assessment.

GPA. Student GPA at the time of graduation for each Cohort was used to compare the achievement levels of the target and comparison groups. Students' weighted GPA was utilized in this study to account for advanced mathematics and science courses with rigorous standards. The grade and bonus point values shown in Table 3 were used to determine students' weighted (with bonus points) GPA's for Cohort 2 and 3. Before 2013, students' weighted GPAs were unlimited. However, the GPA scale utilized after

2013 limited the weighted GPA to 6.0 in an effort to provide consistency among high schools when reporting grades (A. Carvalho, personal communication, May 8, 2013).

Table 3

Grade Point Values

		Bonus Points		
Letter Grade	Grade Points	Honors/Pre-AICE/Pre-IB (Total Points)	AP (Total Points)	IB/AICE (Total Points)
A	4	1 (5)	2 (6)	2 (6)
B	3	1 (4)	2 (5)	2 (5)
C	2	1 (3)	1 (3)	1 (3)
D	1	0 (1)	0 (1)	0 (1)
F	0	0	0	0

Note. Florida Statute 1007.271 states that dual enrollment courses are awarded the equivalent of Advanced Placement (AP), International Baccalaureate (IB), or Advanced International Certificate of Education (AICE) bonus points.

Students who participate in Honors/Pre-AICE/Pre-IB earn one bonus point per course. By contrast, students in Advanced Placement and/or International Baccalaureate (IB)/Advanced International Certificate of Education (AICE) courses earn two bonus points per course towards the weighted GPA. The GPA used for determining the final rank in class for students includes grades from all courses in which credits have been earned for high school graduation and the first semester of the students' final year. The grade and bonus point values shown in Table 3 are used in determining unweighted (without bonus points) and weighted (with bonus points) GPA's. Bonus points are applied to grades earned in individual courses prior to the calculation of the weighted GPA (M-DCPS, 2018a).

Number of mathematics and science courses completed. The Office of Assessment, Research, and Data Analysis provided the data on the mathematics and science courses each student took along with the grade earned for each course. We compiled this data by Cohort to determine the number of mathematics and science courses students successfully completed.

Teacher and principal surveys. To add depth via qualitative information to this explanatory mixed methods study, teacher and principal surveys were conducted.

Teacher survey. We used the Teacher Efficacy and Attitudes toward STEM (T-STEM) Surveys developed by the Friday Institute for Educational Innovation at the University of North Carolina (2012b, 2012c, 2012d, and 2012e). The creators of the survey produced four versions of the survey, each with one difference based on the STEM discipline. For example, the survey provided to mathematics teachers was identical to the survey provided to science teachers, except the authors replaced the word mathematics with science. This change was conducted for each STEM discipline. We were granted permission by the Friday Institute for Educational Innovation to utilize their surveys (see Appendices D, E, F, and G).

The T-STEM surveys "contain two validated, reliable scales, or sets of items which most confidently describe a single characteristic of the survey-taker when calculated as a single composite result" (Faber et al., 2015, p. 6). According to Faber et al. (2015a), the first scale, *Personal Teaching Efficacy and Beliefs* (PTEBS), measures teacher's confidence in their teaching skills in the STEM area in which they teach. The second scale, *Teaching Outcome Expectancy Beliefs* (TOES), measures the degree to which teachers believe student learning can be impacted by effective teaching. These two surveys asked teachers to assess the degree to which they agree with statements using a 5-point Likert scale ranging from *Strongly Disagree* to *Strongly Agree*. A third survey, STEM Instruction, asked teachers to report the frequency with which they used specific

STEM instructional practices using a 5-point Likert scale ranging from *Never* to *Every Time*. The T-STEM survey included sections that addressed four other constructs; however, this study utilized PTEBS, TOES, and STEM Instruction.

The PTEBS, TOES, and STEM Instruction surveys were adapted from the Science Teaching Efficacy Beliefs Instrument (Riggs & Enochs, 1990). The surveys were updated by researchers at the University of North Carolina’s Friday Institute to include modern and accurate language and practices and to focus on student growth rather than achievement (Faber et al., 2015b). The revised surveys were then administered to mathematics, science, engineering, and technology teachers.

The T-STEM surveys were “evaluated using exploratory factor analysis with principal axis factoring and Promax rotation” (Unfried, Faber, Townsend, & Corn, n.d., p. 6). Unfortunately, the sample size was not large enough to thoroughly analyze the surveys. However, reliability was established for PTEBS, TOES, and STEM Instruction with mathematics and science teachers using Cronbach’s Alpha (see Table 4 for reliability information).

Table 4

Chronbach’s Alpha for T-STEM Surveys by Construct

		’**α**		
Subject	*n*	PTEBS	TOES	STEM Instruction
Mathematics	253	.94	.87	--
Technology/Engineering	67	--	--	--
Science	338	.92	.84	.93

Note. T-STEM = Teacher Efficacy and Attitudes toward STEM; PTEBS = Personal Teaching Efficacy and Beliefs scale; TOES = Teaching Outcome Expectancy Beliefs scale; STEM = Science, Technology, Engineering, and Mathematics

Principal survey. We administered the Principal Leadership for STEM (P-STEM survey) to the principals and assistant principals of the 12 target schools. This survey was developed by the Friday Institute for Educational Innovation (2012a) at the University of North Carolina. It was modeled after a survey also developed by the Friday Institute for Educational Innovation to measure principal leadership for one-to-one laptop initiatives. We were granted permission by the Friday Institute for Educational Innovation to utilize their survey (see Appendix H).

The P-STEM survey provided us with information to better understand the school level context for STEM. According to Unfried et al. (n.d.), the self-assessment gives principals the opportunity to self-report their leadership for STEM in the areas of instructional technology; teaching and learning about STEM careers; STEM instructional practices, such as project-based learning and performance assessments; STEM education culture, such as focus on innovation, collaboration, and authentic learning; and best practices for educational leadership such as distributed leadership practices (see Appendix C).

The P-STEM survey uses a five-point Likert scale for responses. It was initially administered to 107 principals and validated through an exploratory factor analysis of the results. The survey was revised based on the results. The survey was then rated by 15 subject matter experts who recommended that 10 additional items be removed and seven added. Reliability for this instrument has not been established due to the small sample size (Unfried et al., n.d.).

Data Collection

This study utilized an explanatory mixed methods design. Therefore, we collected quantitative data through a review of district data, including graduation rate, grade point averages, number of mathematics and science courses taken, and a survey of

STEM teachers and administrators within the subject schools. We collected qualitative data by including four open-ended questions on the principal and teacher surveys. These questions provided participants with an opportunity to share their perceptions of factors that inhibited or contributed to student success in a STEM magnet program.

Initially, a criterion-based selection was used to identify schools that qualified for the study. A systematic identification process searched for high schools within M-DCPS that had a magnet STEM-themed curricular program within the school. None of the targeted schools were whole school magnet programs. A review of the data identified 12 schools meeting the selection criteria.

Research question 1A. M-DCPS retains graduation records for all students within cohort groups and maintains cohort participants' withdrawal codes to account for attrition. We obtained these reports from M-DCPS. The District also provided a list of graduation codes that identified graduates, non-graduates, and students removed from graduation cohorts.

Research questions 1B, 2A, and 2B. M-DCPS maintains Student Course Credit History information, per student, which provided the information that answered these questions, including GPA and courses students had taken in high school (whether passed or not). We obtained these data from M-DCPS for each student included in the study.

Research questions 3A and 3B. We obtained administrators' perceptions of their leadership for STEM instruction. We also collected teachers' perceptions of their efficacy and beliefs, impact on student outcomes, and STEM instructional practices. We utilized two surveys developed by the Friday Institute at the University of North Carolina. The T-STEM survey was transmitted through Qualtrics to 369 teachers, and the P-STEM was transmitted to 51 administrators at the target schools. We emailed the STEM teachers from each focus school, using their district email addresses, on July 1, 2019, and invited them to complete the survey by July 26, 2019. Subsequently, six follow-up emails were sent as reminders to complete the survey.

Research question 4. We obtained teachers' and administrators' opinions about the factors that contributed to or inhibited student success in a STEM magnet program through four open-ended questions on the T-STEM and P-STEM surveys.

Data Analysis

Research question 1A. M-DCPS maintains graduation records for all students. We collected this data for all students in Cohorts 1, 2, and 3 of selected schools from M-DCPS . We excluded graduation data from students who did not meet the same entrance requirements as magnet students from this study. Students must have earned Honors Algebra I and Honors Earth Space Science (Cohort 1) or Honors Physical Science (Cohorts 2 and 3) credits in the eighth grade to meet eligibility criteria for STEM magnet programs. We obtained nominal data and analyzed the data utilizing the chi-square test.

Research questions 1B, 2A, and 2B. M-DCPS maintains Student Course Credit History information, per student, which provided the information that answered these questions, including GPA and courses students take in high school (whether passed or not). We obtained this quantitative data for each student from M-DCPS. We obtained interval data and analyzed the data utilizing an analysis of variance (ANOVA).

Research questions 3A and 3B. We utilized T-STEM and P-STEM surveys to collect data. The T-STEM survey was analyzed based on three constructs: Teaching Efficacy and Beliefs, Teaching Outcome Expectancy, and STEM Instruction. We obtained interval data and analyzed this data comparing the means of magnet and non-magnet teachers using a t-test for independent means for each construct.

The P-STEM survey was not formally analyzed due to the small sample size. However, survey results were used for descriptive purposes.

Research question 4. The qualitative data for this study were collected at the same time as the quantitative data through an online survey. However, as this was an explanatory mixed-methods study, the qualitative data was analyzed after analyzing the quantitative data. There were four open-ended questions on the T-STEM and P-STEM surveys. As a result, there was a limited amount of qualitative data; however, it converged with the quantitative data to provide a better understanding of the issues related to STEM magnet programs. According to Mertler (2017), merging quantitative and qualitative data "results in a more comprehensive view of the topic being investigated" (p. 196).

Coding was employed to sort through and organize the qualitative data into categories and themes (Lauer, 2006; Saldaña, 2016). Saldaña (2016) suggests that coding is "just one way of analyzing qualitative data, not the way" (p. 3); however, it can be an effective tool for representing the primary content of data. Furthermore, coding links ideas with data to illuminate meaning. We based our approach to coding on grounded theory. Grounded theory provides a set of inductive methods for conducting qualitative research. In this approach, codes are developed from the survey responses, and the process leads to the development of new theories. Charmaz (2009) suggests that grounded theory is important because it provides clear guidance for conducting qualitative research and provides a vehicle to legitimize scientific inquiry of qualitative data.

We performed the coding collaboratively. According to Saldaña (2016), “multiple minds bring multiple ways of analyzing and interpreting the data” (p. 36). Moreover, Olesen, Droes, Hatton, Chico, and Schatzman (1994) suggest that researchers working together may pose questions that lead to additional data. While Saldaña (2016) emphasizes the importance of coordinating individual coding efforts, his concerns do not apply to our research, because our collaborative coding was done face to face for each data set.. It may be interesting to note that we considered using a software program to help code the open-ended survey responses. However, after much thought, we agreed that there was no substitute for our collective historical knowledge of the STEM magnet programs within the selected school district and our judgment in making sure the codes were appropriate.

According to Saldaña (2016), researchers should “never overlook the opportunity to pre-code” (p. 20) by identifying quotes or passages that may inform the findings. As a result, the first time we read the responses, the goal was to look for responses that captured our attention. These responses were not coded; they were highlighted for later coding.

First cycle coding is the process of initially identifying codes that represent the responses. For this study, answers to questions 4A and 4B were coded using inductive, or In Vivo Coding during the first cycle of coding. In Vivo Coding involves taking the codes directly from the participants’ statements. Since the respondents answered the open-ended questions in their own words, this approach seemed appropriate. In Vivo

Coding is not a sole coding approach to data; however, it allows researchers to explore the ideas and emotions expressed in responses to analyze phenomena by using identified trends and frequency of responses (Saldaña, 2016, p. 77). We then used Descriptive Coding to make further sense of the responses. This type of coding describes the topics of the responses. Saldaña (2016) suggests that Descriptive Coding is appropriate for all types of qualitative studies and assists researchers in identifying core categories within the data. By aligning and comparing the In Vivo and Descriptive Codes, we were able to organize the data and understand the data from the respondents' perspectives. This information set the stage for the second cycle of coding.

During the second cycle of coding, researchers used Pattern Coding. According to Saldaña (2016), Pattern Coding looks at similarities, frequencies, sequences, and differences in the first cycle codes. Pattern Coding also allows researchers to summarize data from first cycle coding into categories, themes, or concepts. We assembled similarly coded passages from the In Vivo and Descriptive Coding and used the grouped codes to determine Pattern Codes. Based on the Pattern Codes five themes emerged from the data.

The data were organized in an Excel document to include raw data, In Vivo Codes, Descriptive Codes and Pattern Codes. Through this process, the frequency of responses that led to each identified theme was established. See Table 5 for a summary of the research questions, data sources, data types, and data analysis.

Table 5

Summary of the Research Questions, Data Sources, Type and Analysis

Research Question	Data Sources	Data Type	Data Analysis
1: How do students who participate in a high school STEM magnet program perform academically?	M-DCPS		
a. What is the graduation rate for students in STEM magnet programs compared to students from target schools not participating in the STEM magnet program?		Nominal	Chi-square test
b. What is the average GPA of students graduating from STEM magnet programs, compared to students from target schools not participating in the STEM magnet program?		Interval	ANOVA
2: How many mathematics and science credits do students in STEM magnet programs successfully earn during four years of high school, compared to students from target schools not participating in the STEM magnet program?	M-DCPS – Student Credit History	Interval	ANOVA
a. How many mathematics credits beyond the four required courses for graduation do students in STEM magnet programs successfully complete?			
b. How many science credits beyond the three required courses for graduation do students in STEM magnet programs successfully complete?			
3: What are administrators and teacher perceptions regarding STEM instruction?	Survey	Interval	Administrator data used for descriptive purposes. Compare magnet to non-magnet teachers with a t-test for independent means.
a. What are the administrators' perceptions of their leadership for STEM instruction?			
b. What are the teachers' perceptions of their efficacy and beliefs, impact on student outcomes, and STEM instructional practices?			
4: What factors contribute to, or inhibit, a student's successful completion of a STEM magnet program?	Survey	Qualitative	In Vivo Coding Descriptive Coding Pattern Coding

Note. STEM = science, technology, engineering, and mathematics; GPA = grade point average; M-DCPS = Miami-Dade County Public Schools

Delimitations, Limitations, Assumptions

This section describes how the study was narrowed in scope and explains the delimitations, limitations, and assumptions of the study. The outcomes for this research study were to determine the effect on student achievement among those enrolled in

STEM magnet programs, compared to the achievement of non-STEM students within the targeted schools.

Delimitations. Delimitations are factors that may affect a study over which the researcher has control (Lauer, 2006). The quantitative portion of this study considered the data from 12 schools. We chose to study magnet programs within a school or schools that follow the selective model. This decision was deliberate because many schools locally and nationally follow the selective model, therefore the findings of this study may be relevant to a more significant number of schools.

We also chose to send the survey to participants during the summer when many teachers were not working. The survey window was initially open for four weeks, and the response rate was low. We had posited that teachers would be more available and less stressed and, therefore, more likely to take the time to thoroughly and honestly respond to the survey. Due to the low response rate, the survey window was extended twice, first until August 20, 2019, and then until September 15, 2019. The response rate remained low—less than 20%.

Limitations. Limitations are factors over which the researchers have no control that may have affected the study's results or interpretation (Lauer, 2006). There were several limitations to the current study. The first significant limitation resulted from the limited number of schools included in the study. Generalizations were challenging to draw due to this limitation. To account for this limitation, we conducted the same study for three graduation cohorts per school, thus providing a representation of results for each school.

A second limitation was the willingness of survey respondents to be forthright in their opinions and answers. We attempted to ensure participants that their comments would be completely anonymous and would be used only to help explain the quantitative data.

The limitations of this study extended to the time required to access and disaggregate these data. This study required a significant amount of time to collect the data, disaggregate the data, and analyze the data with the potential of acquiring thousands of data points per school. We worked collectively on the collection, disaggregation, and analysis of these data to alleviate concerns.

The collection method for the qualitative portion of the study was potentially a limitation. Student quantitative data were collected on magnet STEM participants and non-STEM magnet participants for three graduation cohorts. However, the teachers' and administrators' perceptions of STEM programs were collected during the summer after the 2018-2019 academic year. As such, there was a likelihood that some survey respondents might not have taught the students in the targeted cohorts. Therefore, we would not be able to conclude that the perceptions of the teachers and administrators were based on the academic performance of the targeted cohorts. To address this limitation, we surveyed all STEM teachers within the 12-school sample. In addition, we initially planned to survey only principals of the 12 schools. However, there was only one principal at each school, and it was uncertain how many would respond. As a result, the sample size would likely have been small and might have made it difficult to maintain the confidentiality of the subjects; therefore, this strategy did not seem viable. To address this limitation, we invited assistant principals from each school to also complete the survey. The administrators’ survey responses were used for descriptive purposes only.

Assumptions. We assumed that students meeting criteria for admission into a STEM magnet program were equally capable of completing a STEM magnet course of study. Additionally, we assumed that students with a positive graduation code completed all graduation requirements (see Appendix A). We further assumed that magnet student records were coded correctly in the computers by the schools they attended. We assumed that students who were enrolled in Geometry or a higher-level mathematics course in ninth grade successfully completed the prerequisite courses before ninth grade (e.g., Geometry students completed Algebra I; Algebra II students completed both Algebra I and Geometry). Similarly, we assumed that students who were enrolled in Biology or a higher-level science course in ninth grade successfully completed the prerequisite courses prior to ninth grade (e.g., Biology students completed Honors Earth Space Science or Honors Physical Science depending on the cohort; chemistry students completed both Honors Earth Space Science or Honors Physical Science and Biology). We also acknowledged that while STEM magnet strands at each school were different, the curricula were equally rigorous. Additionally, we assumed that teachers and administrators responded to the survey questions honestly.

Ethical Considerations

The research, data collection, and analysis in this study began once institutional review board (IRB) approval was obtained from the College of William & Mary, followed by approval from M-DCPS. This study adhered to the guidelines and procedures outlined by both institutions. The College of William and Mary determined that the project was exempt from IRB requirements due to the nature of the study. All teacher and principal participants were given the opportunity to acknowledge their consent to participate in the research before completing the survey administered through Qualtrics. Participants were also informed of the purpose of the research and assured that their responses would remain confidential.

Participants’ names and identifiers were suppressed in the final research report and were not linked with any named school. A digital survey tool was utilized. No identifiable data were released to third parties to protect the anonymity of all participants. This ensured protection from harm to participants, remained consistent with the agreement of informed participation, and gave all professional colleagues the right to maintain privacy and transparency (Mertler, 2017).

Summary

This study employed an explanatory mixed methods approach by collecting both quantitative and qualitative data. Most of the data were quantitative, and the qualitative data was examined after the quantitative data had been analyzed. The qualitative data informed us about the perception of the participants and provided insight into the quantitative data results. This approach provided us with a comprehensive analysis of the issue by merging quantitative and qualitative data (Creswell, 2014).

We studied the effect of STEM magnet education on academic achievement by analyzing graduation rates, GPA, and mathematics and science courses completed by students from selected high schools. The study was conducted in 12 traditional high schools that had a STEM magnet program. The selected schools had minimally six years of data. This allowed us to collect data for three graduating Cohort years: 2011-12, 2012-

13, and 2013-14. Magnet STEM students were the target group, and the non-STEM students were the comparison group. Since students in a STEM magnet program had an entrance requirement of successfully completing Honors Algebra I and Honors Physical Science (or Earth Space Science for students in Cohort 1) in eighth grade, the same criteria were used to identify the comparison group of students in the traditional program. Additionally, STEM teachers, principals, and assistant principals from the 12 schools completed a survey that provided both quantitative and qualitative data and captured their perceptions of STEM education and its impact on student outcomes.

We identified two delimitations including choosing to study magnet programs within a school or schools that followed the selective model and sending the survey to participants during the summer when many teachers would not be working. Nevertheless, we were deliberate with these delimitations.

Four limitations were identified: the number of schools included in the study, the willingness of survey respondents to be forthright in their opinions and answers, the time required to access and disaggregate these data, and the collection method for the qualitative portion of the study. However, we accounted for these limitations and took steps to nullify each. Therefore, we posit that the findings of this study will be relevant to a significant number of schools.

CHAPTER 4

FINDINGS

This study explored the effects of participating in a high school STEM magnet program on student achievement and analyzed the self-reported instructional practices and perceptions of STEM teachers and administrators of schools with STEM magnet programs. Data were collected through student records available through the school district, and surveys were administered to teachers and administrators of schools with STEM magnet programs. The sample included students, teachers, and administrators from 12 schools. Student achievement was defined as GPA, graduation rate, and number of mathematics and science courses successfully passed beyond those required for graduation. Graduation rate data were analyzed using chi-square. GPA data and data regarding courses successfully passed were analyzed utilizing analysis of variance. Data from the quantitative portions of the teacher and administrator surveys were analyzed using a t-test for independent means and a descriptive analysis, respectively. The qualitative portions of the surveys were analyzed using coding techniques.

This chapter provides demographic information on the teacher and administrator participants, including a table of homogeneity for the teacher participants compared to the population of teachers invited to answer the T-STEM survey. It also presents the findings by research question.

Demographic Information

Teachers. The population of STEM teachers in the 12 schools equaled 389. Twenty-four teachers declined to participate in the survey, and 12 emails failed. Sixty-eight teachers responded to the survey, with an overall response rate of 17.48%. Table 6 presents demographic information of the teacher participants, including race, gender and subject taught, by frequency and percentage, along with a comparison of the population to the respondents.

Table 6

Teacher Homogeneity of Responses

Demographic Category	Opted Out (24)	Non-Respondents (297)	Completed Surveys (68)	Total Population (389)	Population Demographics	Respondent Demographics
Race						
Hispanic	12	146	34	192	49%	48%
Black	3	75	13	91	23%	20%
White	9	68	19	96	25%	30%
Asian	0	6	2	8	2%	2%
American Indian/ Alaskan	0	2	0	2	1%	0%
Gender						
Male	8	121	30	159	41%	42%
Female	16	176	38	230	59%	58%
Subject Taught						
Mathematics	12	122	28	162	42%	38%
Science	5	95	24	124	32%	38%
Technology/ Engineering	6	76	16	98	25%	23%
Magnet Lead Teacher	1	4	0	5	1%	0%

Interestingly, the respondents match the population closely in many aspects. There are two areas where the population least matches the respondents: White teachers represent 25% of the population compared to 30% of the respondents. Also, science teachers represent 32% of the population compared to 38% of the respondents. All other comparisons are separated by no more than 4 percentage points with many comparisons separated by only 1 percentage point.

Administrators. The population of administrators in the 12 schools included 12 principals and 39 assistant principals. One administrator declined to participate in the survey. A total of 38 administrators responded to the P-STEM Survey, with an overall response rate of 74.5%.

Research Question 1: How do students who participate in a high school STEM magnet program perform academically?

To determine the academic performance of magnet students, we considered graduation rate and grade point average of students who participated in all four years of a high school STEM magnet program and compared their performance to the performance of students who met the magnet entrance requirements but did not participate in the magnet program.

Graduation rate comparison. The graduation rate was calculated by magnet status for each cohort after eliminating students who were removed to verified alternate locations from the cohort. Figure 1 displays these data. A chi-square test of independence comparing the graduation rates of the magnet and non-magnet students was calculated for each cohort group.

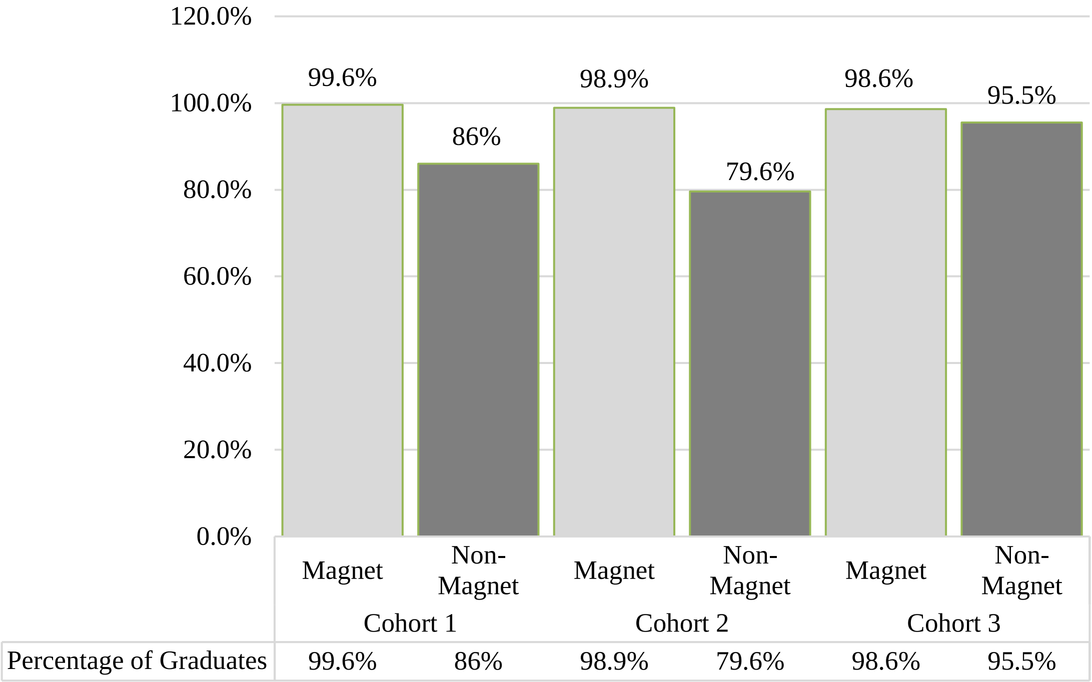


Figure 1. The percentage of on time graduates by cohort of magnet versus non-magnet students.

Cohort 1 (Students entering 9th grade in 2011). The chi-square [χ^2 (1, N=1271) = 67.167, p < .001] test of association indicated that there was a relationship between the variables. The Phi correlation coefficient, Φ = .230 indicates that there was a small effect size. Magnet students in Cohort 1 were more likely to graduate from high school than non-magnet students meeting the same eligibility criteria.

Cohort 2 (Students entering 9th grade in 2012). The chi-square [χ^2 (1, N=1282) = 129.165, p < .001] test of association indicated that there was a relationship between the variables. The Phi correlation coefficient, Φ = .317 indicates that there was a moderate effect size. Magnet students in Cohort 2 were more likely to graduate from high school than non-magnet students meeting the same eligibility criteria.

Cohort 3 (Students entering 9th grade in 2013). The chi-square [χ^2 (1, N=1463) = 12.667, p < .001] test of association indicated that there was a relationship between the variables. The Phi correlation coefficient, $\Phi = .093$ indicates that there was a very small effect size. Magnet students in Cohort 3 were more likely to graduate from than non-magnet students meeting the same eligibility criteria.

Considered together, magnet students in all three cohorts were more likely to graduate from high school; however, the effect size was relatively small. Table 7 presents the crosstabulation for graduation status for magnet versus non-magnet student cohort groupings.

Table 7

Crosstabulation for Magnet Status versus Graduation Status for Cohort Groupings

			Graduation Status		
Cohort	Magnet Status	Count Information	Non-Graduate	Graduate	Total
1	Non-Magnet	Count	111	685	796
		Expected Count	70.8	725.2	796.0
		% within Graduation Status	98.2%	59.2%	62.6%
	Magnet	Count	2	473	475
		Expected Count	42.2	432.8	475.0
		% within Graduation Status	1.8%	40.8%	37.4%
	Total	Count	113	1158	1271
		Expected Count	113.0	1158.0	1271.0
		% within Graduation Status	100.0%	100.0%	100.0%
2	Non-Magnet	Count	125	489	614
		Expected Count	63.2	550.8	614.0
		% within Graduation Status	94.7%	42.5%	47.9%
	Magnet	Count	7	661	668
		Expected Count	68.8	599.2	668.0
		% within Graduation Status	5.3%	57.5%	52.1%
	Total	Count	132	1150	1282
		Expected Count	132.0	1150.0	1282.0
		% within Graduation Status	100.0%	100.0%	100.0%
3	Non-Magnet	Count	30	641	671
		Expected Count	18.8	652.2	671.0
		% within Graduation Status	73.2%	45.1%	45.9%
	Magnet	Count	11	781	792
		Expected Count	22.2	769.8	792.0
		% within Graduation Status	26.8%	54.9%	54.1%
	Total	Count	41	1422	1463
		Expected Count	41.0	1422.0	1463.0
		% within Graduation Status	100.0%	100.0%	100.0%
Total	Non-Magnet	Count	266	1815	2081
		Expected Count	148.2	1932.8	2081.0
		% within Graduation Status	93.0%	48.7%	51.8%
	Magnet	Count	20	1915	1935
		Expected Count	137.8	1797.2	1935.0
		% within Graduation Status	7.0%	51.3%	48.2%
	Total	Count	286	3730	4016
		Expected Count	286.0	3730.0	4016.0
		% within Graduation Status	100.0%	100.0%	100.0%

GPA comparison. A two-way ANOVA was conducted that examined the effect of magnet status and cohort year on grade point average. Table 8 presents descriptive statistics for GPA by cohort and magnet status. Table 9 presents ANOVA tests for between-subjects' effects on GPA. There was a statistically significant interaction between the effects of magnet status and cohort year, F (2, 3730) = 10.413, p < .001. On average, students in STEM magnet programs had a higher GPA than non-magnet students in each cohort grouping. Cohort 1 had the highest mean difference in GPA. However, it must be noted that the range in bonus points for Cohort 1 students was greater than in Cohorts 2 and 3. Bonus points are additional points toward the GPA that students earn for each honors, AP, IB, and dual enrollment course. Figure 2 displays the mean GPAs by cohort grouping of magnet versus non-magnet students.

Table 8

Descriptive Statistics for Grade Point Average by Cohort and Magnet Status

Cohort	Magnet Status	*M* GPA	*SD*	*N*
1	Non-Magnet	4.8174	1.0929	685
	Magnet	5.3872	1.0672	473
	Total	5.0501	1.1177	1158
2	Non-Magnet	3.9009	.7358	489
	Magnet	4.2106	.6163	661
	Total	4.0789	.6867	1150
3	Non-Magnet	3.9018	.7343	641
	Magnet	4.1926	.6573	781
	Total	4.0615	.7078	1422
Total	Non-Magnet	4.2471	.9917	1815
	Magnet	4.4939	.9219	1915
	Total	4.3738	.9643	3730

Note. The Miami-Dade County Public Schools official grade point average (GPA) scale is 0-4; however, with bonus points, the GPA was unlimited for Cohort 1 students, whereas due to District GPA policy changes the GPA was limited to 6.0 for Cohort 2 and 3 students.

Table 9

ANOVA Tests of Between-Subjects Effects on Grade Point Average

Source	Type III *SS*	*df*	*MS*	*F*	Sig.
Cohort	857.820	2	428.910	626.017	.000
Magnet Status	137.339	1	137.339	200.453	.000
Interaction	14.269	2	7.134	10.413	.000
Error	2551.465	3724	.685		
Total	74822.747	3730			
Corrected Total	3467.349	3729			

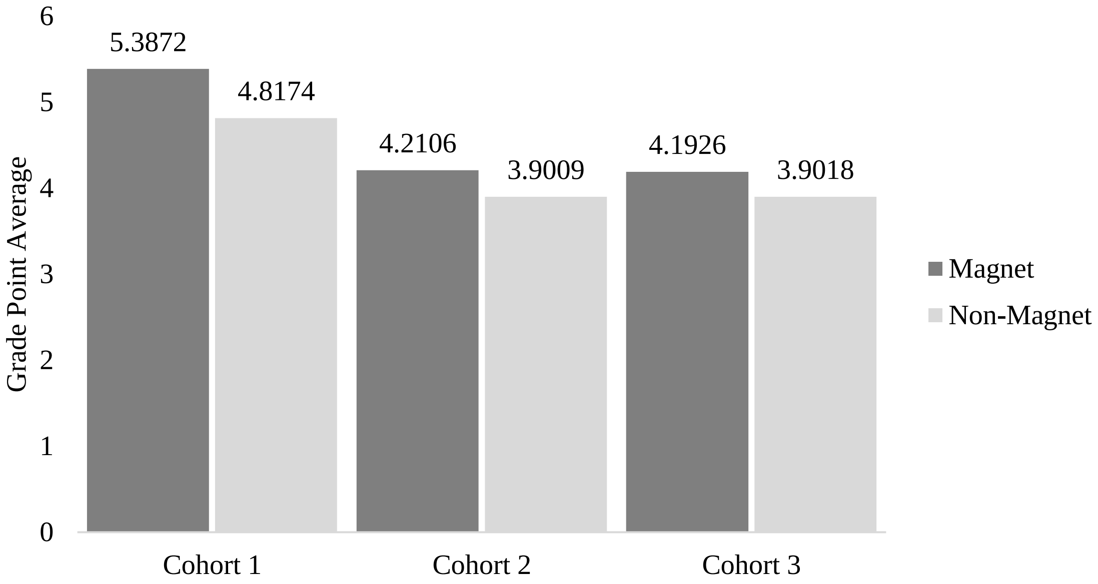


Figure 2. Mean GPAs by cohort grouping of magnet students versus non-magnet students.

Research Question 2: How many mathematics and science credits do students in STEM magnet programs successfully earn during four years of high school, compared to students from target schools not participating in the STEM magnet program?

To determine the academic performance of magnet students from another vantage point, we considered the number of mathematics and science courses successfully completed by students who participated in all four years of a high school STEM magnet programs and compared their performance to the performance of students who met the magnet entrance requirements but did not participate in the magnet program.

Mathematics course comparisons. A two-way ANOVA was conducted that examined the effect of magnet status and cohort year on the number of mathematics courses successfully completed beyond those required for graduation. Courses were counted only for those students who graduated from one of the 12 subject schools. Successful completion required a passing grade of D or better. There was a statistically significant interaction between the effects of magnet status and cohort year, F (2, 3730) = 17.176, $p < .001$. On average, students in magnet programs took a slightly higher number of courses beyond those required for graduation than did non-magnet students. However, the differences in Cohort 1 (.08 courses) and 2 (.03 courses) were so small that there may be no practical significance. The difference between the mean number of courses above those required for graduation between the magnet and non-magnet students in Cohort 3 was 0.29, still relatively small. Table 10 presents descriptive statistics for number of mathematics courses taken by cohort and magnet status. Table 11 presents tests of between subjects' effects on number of mathematics courses taken.

Table 10

Descriptive Statistics on Number of Mathematics Courses Taken by Cohort and Magnet Status

Cohort	Magnet Status	*M* courses beyond graduation requirement	*SD*	*N*
1	Non-Magnet	.74	.630	685
	Magnet	.82	.630	473
	Total	.77	.631	1158
2	Non-Magnet	.63	.535	489
	Magnet	.66	.501	661
	Total	.65	.516	1150
3	Non-Magnet	.63	.647	641
	Magnet	.92	.636	781
	Total	.79	.657	1422
Total	Non-Magnet	.67	.614	1815
	Magnet	.81	.601	1915
	Total	.74	.611	3730

Table 11

Tests of Between-Subjects Effects on the Number of Mathematics Courses Taken

Source	Type III *SS*	*df*	*MS*	*F*	Sig.
Cohort	13.010	2	6.505	17.984	.000
Magnet Status	16.691	1	16.691	46.145	.000
Interaction	12.425	2	6.213	17.176	.000
Error	1346.977	3724	.362		
Total	3443.000	3730			
Corrected Total	1393.342	3729			

Science course comparisons. A two-way ANOVA was conducted that examined the effect of magnet status and cohort year on the number of science courses successfully completed beyond those required for graduation. Table 12 presents descriptive statistics for the number of science courses taken by cohort and magnet status. Table 13 presents tests of between subjects' effects on number of mathematics courses taken. There was no statistically significant interaction between the effects of magnet status and cohort year, F (2, 3730) = 1.512, p = 0.221. Examination of the magnet status main effect showed that there was a statistically significant difference in the number of science courses magnet students took beyond those required for graduation compared to those taken by non-magnet students. However, the magnitude of these differences was so small (Cohort 1: .06 courses, Cohort 2: .18 courses, and Cohort 3: .08 courses) that there may be no practical significance.

Table 12

Descriptive Statistics on Number of Science Courses Taken by Cohort and Magnet Status

Cohort	Magnet Status	*M* courses beyond graduation requirement	*SD*	*N*
1	Non-Magnet	1.34	.713	685
	Magnet	1.40	.640	473
	Total	1.36	.684	1158
2	Non-Magnet	1.82	1.038	489
	Magnet	2.00	.990	661
	Total	1.92	1.014	1150
3	Non-Magnet	1.10	.955	641
	Magnet	1.18	1.001	781
	Total	1.14	.981	1422
Total	Non-Magnet	1.38	.940	1815
	Magnet	1.51	.988	1915
	Total	1.45	.967	3730

Table 13

Tests of Between-Subjects Effects on the Number of Science Courses Taken

Source	Type III *SS*	*df*	*MS*	*F*	Sig.
Cohort	376.014	2	188.007	227.413	.000
Magnet Status	9.884	1	9.884	11.955	.001
Interaction	2.499	2	1.250	1.512	.221
Error	3078.710	3724	.827		
Total	11341.000	3730			
Corrected Total	3485.620	3729			

Research Question 3: What are administrator and teacher perceptions regarding STEM instruction?

To provide clarity and context to the student academic performance data, we administered a survey to all administrators and STEM teachers in the 12 schools. A discussion of the findings, by administrators and teachers, follows.

Administrators' perceptions. We administered a 34-item survey to administrators in the 12 schools. Administrators rated their agreement with statements utilizing a 5-point Likert scale with responses ranging from *Strongly Agree* to *Strongly Disagree*. The first 18 survey items referred to general leadership and the remaining items referred to leadership for STEM (Faber et al., 2015b). On the items related to general leadership, 91.6% of respondents selected *Strongly Agree* or *Agree*. However, 77.7% of the respondents selected *Strongly Agree* or *Agree* on the items related to leadership for STEM education. The P-STEM survey results by percentage and frequency of responses are include in Table 14.

Table 14

P-STEM Survey Results

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
At my school, I have articulated a vision.	58.3% (21)	36.1% (13)	5.6% (2)	0.0%	0.0%
At my school, I model inquiry-based learning.	30.6% (11)	52.8% (19)	13.9% (5)	0.0%	2.8% (1)
At my school, I encourage a culture of innovation among teachers and students.	55.6% (20)	36.1% (13)	2.8% (1)	0.0%	5.6% (2)
At my school, I make sure teachers have access to resources for STEM teaching and learning (e.g., lab facilities, project supplies, lab equipment, project rooms, etc.).	44.4% (16)	47.2% (17)	5.6% (2)	2.8% (1)	0.0%
At my school, I ensure technical support is available for instructional technology needs.	52.8% (19)	47.2% (17)	0.0%	0.0%	0.0%
At my school, I make sure teachers have access to instructional technology tools that facilitate their work (e.g., laptops, digital projectors, software, virtual applications, learning management systems, etc.).	72.2% (26)	19.4% (7)	8.3% (3)	0.0%	0.0%
At my school, I ensure technical support is available for lab equipment and/or other resources for STEM teaching.	58.3% (21)	36.1% (13)	2.8% (1)	2.8% (1)	0.0%
At my school, I share research and best practices with teachers.	44.4% (16)	44.4% (16)	8.3% (3)	2.8% (1)	0.0%
At my school, I support teachers to implement project-based learning.	47.2% (17)	41.7% (15)	8.3% (3)	2.8% (1)	0.0%
At my school, I understand that incorporating inquiry-based teaching may take more time for teachers.	44.4% (16)	47.2% (17)	8.3% (3)	0.0%	0.0%
At my school, I include teachers in decision-making.	61.1% (22)	36.1% (13)	2.8% (1)	0.0%	0.0%
At my school, I include teachers in decisions about measuring student success in STEM.	36.1% (13)	52.8% (19)	11.1% (4)	0.0%	0.0%

Table 14 (continued)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
At my school, I request feedback from teachers on the progress of the STEM program.	30.6% (11)	58.3% (21)	11.1% (4)	0.0%	0.0%
At my school, I set ambitious, yet realistic (i.e., not too high, and not too low) goals.	36.1% (13)	52.8% (19)	8.3% (3)	2.8% (1)	0.0%
At my school, I advocate for policies that support STEM education at the district level.	33.3% (12)	41.7% (15)	25% (9)	0.0%	0.0%
At my school, I support teachers using a variety of indicators of student success (e.g., performance-based, project-based, portfolios, etc.).	41.7% (15)	55.6% (20)	2.8% (1)	0.0%	0.0%
At my school, I use multiple sources of data for evaluating the impact on students.	38.9% (14)	58.3% (21)	2.8% (1)	0.0%	0.0%
At my school, I provide constructive feedback to teachers.	61.1% (22)	38.9% (14)	0.0%	0.0%	0.0%
At my school, I implement practices to increase participation of students from underrepresented groups in STEM.	44.4% (16)	50.0% (18)	2.8% (1)	2.8% (1)	0.0%
At my school, I maintain strategic partnerships with STEM industries.	25% (9)	38.9% (14)	25% (9)	11.1% (4)	0.0%
At my school, I set clear expectations for students.	61.1% (22)	33.3% (12)	2.8% (1)	2.8% (1)	0.0%
At my school, I provide space for students to collaborate, work on projects, hold exhibitions, etc.	38.9% (14)	50.0% (18)	8.3% (3)	2.8% (1)	0.0%
At my school, I enable collaboration of teachers across content areas.	52.8% (19)	47.2% (17)	0.0%	0.0%	0.0%
At my school, I provide consistent professional development specific to the STEM program.	13.9% (5)	50.0% (18)	25% (9)	11.1% (4)	0.0%
At my school, I set clear expectations for students.	55.6% (20)	38.9% (14)	5.6% (2)	0.0%	0.0%
At my school, I use an action plan to implement STEM education.	13.9% (5)	47.2% (17)	30.6% (11)	8.3% (3)	0.0%

Table 14 (continued)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
At my school, I provide opportunities for teachers to have applied STEM learning experiences (e.g. industry tours, study trips, job shadowing).	30.6% (11)	41.7% (15)	19.4% (7)	8.3% (3)	0.0%
At my school, I support the formal, in-school provision of authentic learning experiences connected to current STEM research or industry for students.	22.2% (8)	58.3% (21)	19.4% (7)	0.0%	0.0%
At my school, I communicate to the larger community about the STEM program.	19.4% (7)	52.8% (19)	22.2% (8)	5.6% (2)	0.0%
At my school, I support the informal, extracurricular provision of authentic learning experiences connected to current STEM research or industry for students.	27.8% (10)	52.8% (19)	16.7% (6)	2.8% (1)	0.0%
I feel prepared to lead the STEM program.	19.4% (7)	55.6% (20)	13.9% (5)	11.1% (4)	0.0%
I feel confident in leading a STEM program.	22.2% (8)	47.2% (17)	19.4% (7)	8.3% (3)	2.8% (1)
I feel knowledgeable about the characteristics of STEM teaching.	13.9% (5)	63.9% (23)	13.9% (5)	8.3% (3)	0.0%
I feel knowledgeable about the characteristics of STEM learning.	13.9% (5)	55.6% (20)	19.4% (7)	11.1% (4)	0.0%

Administrators generally rated their leadership with the response *Strongly Agree*, *Agree*, and *Neither Agree nor Disagree* throughout the survey; there were few instances where administrators selected the response *Disagree* and almost no instances where the respondents selected the response *Strongly Disagree*. We identified six statements with which 96% or more of the principals strongly agreed or agreed. We chose to highlight this level of agreement because the overall percentage of *Strongly Agree* or *Agree* responses was very high These six include ensuring technical support is available for instructional technology needs, including teachers in decision-making, supporting teachers using a variety of indicators of student success, using multiple data sources to evaluate impact on students, providing constructive feedback to teachers, and enabling collaboration of teachers across content areas. Five of the six responses refer to general leadership practices, and only one was identified as leadership for STEM education by the original survey writers (Faber et al., 2015b). By contrast, we identified five statements to which 20% or more of the principals responded *Neither Agree* nor *Disagree*. These five responses included advocating policies that support STEM education at the District level, maintaining strategic partnerships with STEM industries, providing consistent professional development for STEM educators, utilizing an action plan to implement STEM education, and communicating to the larger community about STEM programs. We chose this comparison because few principals rated any area of the survey as *Disagree* or *Strongly Disagree*.

Teachers' perceptions. Teacher perceptions were measured based on three constructs: Teaching Efficacy and Beliefs, Teaching Outcome Expectancy, and STEM Instruction. A t-test for independent means was used to compare the means of magnet teacher responses to non-magnet teacher responses for each construct. Table 15 provides group statistics on T-STEM results, and Table 16 provides the Independent Samples Test on T-STEM results. There was a statistically significant difference in the means of magnet versus non-magnet teachers in Teaching Efficacy and Beliefs, but no significant differences indicated for the other two constructs. A discussion of the findings for each construct follows.

Table 15

Group Statistics on T-STEM Results

Construct	Teacher Magnet Status	*N*	*M*	*SD*	*SEM*
Teaching Efficacy and Beliefs	Magnet Teachers	20	3.9550	.3485	.0779
	Non-Magnet Teachers	48	3.5904	.7734	.1116
Teaching Outcome Expectancy	Magnet Teachers	20	3.5950	.5561	.1244
	Non-Magnet Teachers	48	3.4946	.5135	.0741
STEM Instruction	Magnet Teachers	20	3.8390	.8296	.1855
	Non-Magnet Teachers	48	3.6546	.7441	.1074

Table 16

Independent Samples Test on T-STEM Survey Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% CI of the Difference	
Construct	Variances	*F*	Sig.	*t*	*df*	Sig. (2-tailed)	*M* Difference	*SE* Difference	Lower	Upper
Teaching Efficacy and Beliefs	Equal variances not assumed	10.579	.002	2.678	65.495	.009	.3646	.13613	.0928	.6364
Teaching Outcome Expectancy	Equal variances assumed	.556	.459	.717	66	.476	.1004	.1400	-.1792	.3800
STEM Instruction	Equal variances assumed	.321	.573	.900	66	.371	.1844	.2049	-.2246	.5934

Personal Teaching Efficacy and Beliefs . The Personal Teaching Efficacy and Beliefs Scale results of magnet and non-magnet teacher groups (see Appendix I) were compared using an independent samples t-test. Levene's test for equality of variances was found to be violated for the present analysis F = 10.579, p=.002. As a result of this violated assumption, a t-test not assuming homogeneity of variances was computed. The t-test [t(68) = 2.678, p=.009] indicated that the groups were significantly different with a large effect size (Cohen's d = .6078). The data on teacher efficacy and beliefs indicate that magnet and non-magnet teachers, in general, report having a high level of confidence in their teaching ability; however, magnet teachers (*M*=3.9550, *SD* = .3485) had, on average, a higher sense of confidence and self-efficacy than non-magnet teachers (*M*=3.5904, *SD* = .7734).

Teaching Outcome Expectancy Scale. The Teaching Outcome Expectancy results of magnet and non-magnet teacher groups (see Appendix J) were compared using an independent samples t-test. Levene's test for equality of variances was not found to be violated for the present analysis F = .556, p = .459. As a result of this assumption, a t-test assuming homogeneity of variance was computed. The t-test [t(68) = .717, p= .476] indicated that the groups were not significantly different. Magnet teachers (*M*=3.5950, *SD* = .5561) had, on average, a slightly higher outcome expectancy of students than non-magnet teachers (*M*=3.4946, *SD* = .5135) but the difference was not statistically significant.

STEM Instruction Survey. The STEM instruction survey results of magnet and non-magnet teacher groups (see Appendix K) were compared using an independent samples t-test. Levene's test for equality of variances was not found to be violated for the present analysis F = .321, p=.573. As a result of this assumption, a t-test assuming homogeneity of variance was computed. The t-test [t(68) = .900, p=.371] indicated that the groups were not significantly different. These results indicate that magnet teachers (*M*=3.839, *SD* = .8296) utilized, on average, a slightly higher number of STEM instructional strategies than non-magnet teachers (*M*=3.6546, *SD* = .7441) but the difference was not statistically significant.

Research Question 4: What factors contribute to, or inhibit, a student's successful completion of a STEM magnet program?

The study revealed prominent themes related to teacher and administrator beliefs regarding factors that contribute to or inhibit a student's successful completion of a STEM magnet program. There were 68 teacher respondents and 38 administrators who completed the survey. Of those, 63 teachers (93%) and 35 administrators (92%) completed the open-ended questions. The open-ended portions of the T-STEM and P-STEM surveys were the primary data sources for Question 4.

During the process of coding, phrases of the respondents' statements were in vivo coded, and then the same statements were assigned descriptive codes. In many cases, the same concepts were raised as both inhibiting and contributing factors. During second cycle coding, pattern coding was employed, and several primary patterns surfaced. We looked at the patterns for similarities and organized them into five predominant themes.

The following predominant themes emerged:

1. Students and their relationship to STEM education: preparation, interest, motivation, and effort.
2. Teachers' ability to deliver STEM education: pedagogy, content knowledge, and demeanor.
3. STEM curriculum: integration, multi-disciplinary approach, relevance, and application.
4. Resources.
5. Lack of program awareness.

Students and their relationship to STEM education: preparation, interest, motivation, and effort. The first predominant theme suggests that student preparation, interest, motivation, and effort play an important role in the level of success or failure a student may experience in a STEM magnet program. There are 79 instances where teachers, and 30 instances where administrators, used language that supports this theme. Student preparation was the most frequent response. There were 34 instances where teachers perceived preparation, or lack thereof, as a significant factor in determining success or failure for a student. T-Respondent 20 stated, “good background of the subject, especially in mathematics,” was essential to the success of students. On the other hand, T-Respondent 48 wrote, “weak math skills. Poor critical thinking skills, reasoning, and problem-solving skills” play a role in hindering a student’s success. Numerous responses from varied teacher respondents reiterated this perception. Four of the teacher responses included “not being at grade level to participate,” “poor math background,” “some students get intimidated by science and math,” and “low basic math skills, reading below grade level. Low critical thinking skills.”

Administrator responses mirrored many of the teacher responses. A-Respondent 21 stated, “lacking math skills,” inhibits students’ successful completion of the STEM magnet program. Another response capturing this sentiment came from A-Respondent 22 who indicated, “lack of proper preparation in the middle school environment in mathematics and science.” Several administrators expressed student preparation as a contributing factor for success in STEM. A-Respondent 23 asserted, “a strong grasp in both mathematics and the sciences,” is essential for success. This sentiment was echoed by A-Respondent 24, who stated, “a strong foundation…in mathematics/science and how these subjects are used in STEM fields." "Student readiness (academic/social ability and confidence)" was mentioned by A-Respondent 29.

Twenty-three teacher respondents indicated that student interest was another key factor. Student motivation was mentioned on 15 occasions, and student effort was mentioned seven times. T-Respondent 18 indicated student success requires "hard work and dedication inside and outside of the classroom," and T-Respondent 37 stated, "hard work and persistence." These statements support that student effort plays a vital role in the perceptions teachers have of its importance relative to students' success. These responses were mostly tied to the level of effort students exhibited as it applies to the learning process.

Student interest was reported by administrators on 20 instances indicating both its positive and negative impact on student success. "Students are not fully vested in the program they are enrolled in," was mentioned by A-Respondent 2. Other comments such as, "In my opinion, students' interest and good performance in STEM subjects contribute to their successful completion of a STEM magnet program." (A-Respondent 17), "students not seeing the value of program completion" (A-Respondent 14), and "The challenge for us is finding students that are interested in Science and Math." (A-Respondent 19), emphasized the administrators' perceptions of student interest and its impact on student success.

Teachers' ability to deliver STEM education: pedagogy, content knowledge, and demeanor. The responses identified the teacher's level of pedagogy, content knowledge, and demeanor as a predominant theme that contributed to a student's achievement or lack thereof in a STEM magnet program. There were 134 instances where teachers and 72 instances where administrators wrote statements to support this theme. Pedagogy surfaced at the top of the list, with 61 teacher responses and 25 administrator responses indicating the role pedagogy plays. T-Respondents referenced the teachers' capacity to "differentiate instruction skills"; "know how to work with their demographics (different students need different styles of instruction)"; and "be able to differentiate content based on students' ability" as essential attributes.

A-Respondents concurred. A-Respondent 8 expressed, "provides students a comprehensive understanding of the topics, hands-on experience, and connections to the industries within STEM programs." A-Respondent 9 emphasized the need for, "understanding and having excellent pedagogy to translate the information, they should also understand and possibly have experience in the real world on the application of the subjects being taught." One respondent noted that, "teachers should be pedagogically trained in the program and prepare lessons that use multiple facets of the program" (A-Respondent 15).

Pedagogy was followed by content knowledge in the respondents' perceptions regarding the role it plays on students' success. T-Respondent 34 stated, "The teacher must be knowledgeable and up to date in the area, he/she has been employed to teach." Similarly, T-Respondent 38 indicated that it is vital for students to have a teacher who "knows their curriculum very well (in particular for AP and upper-division classes)." Content knowledge appears to be a key component in teacher competence that influences student progress.

Administrators' responses were in accord with teachers' responses regarding the impact of content knowledge on student success. A-Respondent 16 mentioned, "Teachers need to be proficient in the STEM subject they teach (science, technology, mathematics, etc.)," while A-Respondent 15 emphasized "content knowledge is an absolute." Additional comments included, "knowledge of the material," "knowledgeable instructors with both educational and practical experience in STEM," and "selecting teachers [who] are knowledgeable in content," accentuating the impact of content knowledge.

Interestingly, teacher demeanor appears to play an important role as well. There were 13 instances among administrators' responses and 34 instances where teachers indicated their ability to motivate, mentor, and inspire overall enthusiasm, along with positive student interactions play a critical role in their success. T-Respondent 5 stated, "the willingness of the teacher to guide, encourage, and serve as a mentor to the student" was an essential factor. Administrators also reported the impact of demeanor, as evidenced by A-Respondent 25's statement, "Teachers - willingness to go over and beyond."

Similar to a teacher's positive demeanor, a negative demeanor also influences a student's ability to achieve. Administrators' and teachers' statements ranged from "love of teaching" and "personal passion for one's craft" to "judgmental adult attitudes about what students can do or accomplish," teachers who "don't put enough time, energy, or passion," and "lack of teacher buy-in regarding STEM initiatives." These statements revealed that demeanor matters regarding student outcomes in terms of facilitating or hindering student outcomes.

STEM curriculum: integration, relevance and application, and multi-disciplinary approach. The level of integration, relevant and applied curriculum, and multi-disciplinary approach were predominant sub-themes, based on the responses recorded by the respondents.

Curriculum integration. Within this theme, integration was cited 26 times by the teachers, and 17 times by administrators. "Integration with all subject areas," wrote one teacher respondent. T-Respondent 27 mentioned, "integration across the curriculum" as a factor that contributes to a student's success. Similarly, an administrator iterated a similar response, "the integration of math, science and technology that includes project-based learning." T-Respondent 68 expressed, "no integration of math, science, and technology to provide them interest in diverse areas" as an inhibiting factor. A-Respondent 10 indicated, "lack of instructional diversity that meets the needs of all students." T-Respondent 23 went as far as to indicate that "although the curriculums are not interlinked, the infusion of STEM is happening in different subjects" when referring to the essential skills a teacher needs to teach in a STEM magnet program.

Relevance. The idea of having a curriculum that is hands-on, relevant to real-life, and filled with applications, instead of just theory, resonated with the teachers and emerged as a pattern within the theme. A variety of teacher respondents indicated "relevance to real-life," "application instead of theory," "opportunity for students to be hands-on," "labs for science," and "build projects for engineering," as contributing factors to the achievement of success for students. T-Respondent 24 went as far as to state that a teacher's ability to use an applied curriculum is an essential skill a teacher needs to succeed in a STEM magnet program by stating the importance of "application and immersing new activities and relevance in the program." Administrators agreed with teachers' opinions. A-Respondent 3 stated, "The teacher needs to understand the correlation among the applications of Science, Engineering, Technology and Mathematics." This was evidenced in another administrator's response, "the skill of teaching real-life application" (A-Respondent 11). On the other hand, one teacher respondent succinctly indicated that an inhibiting factor is a "theory-heavy curriculum." T-Respondent 6 summarized these by commenting, "STEM courses need to be balanced with the right amount of theory and practice, in many cases the teachers are great at the theory part, but the hands-on part eludes them."

Multi-disciplinary approach. STEM programs are often taught in isolation. The ability to use a multi-disciplinary approach to these subjects reverberated with some teachers and administrators. On seven occasions, teachers listed it as a factor that contributed to or inhibited students' success. Administrators mentioned multi-disciplinary as an important factor as well. "Consistency, adherence, and fidelity of teachers in the implementation of cross curricular activities," was reported by A-Respondent 7. "Being able to relate all subjects together" wrote T-Respondent 17. T-Respondent 42 wrote that it is important to "create a cross-curriculum" that engages students and provides them with relevant material. Respondents used multi-disciplinary and inter-disciplinary in their responses. It is important to point out that in a multi-disciplinary approach, each subject area is distinguishable and maintains its identity while subjects in an inter-disciplinary approach are indistinguishable from each other.

Resources. Teachers identified resources as factors that contribute to or inhibit student success in STEM magnet programs on 34 occasions and administrators mentioned it on 10 occasions. Three of the most prevalent resources identified by teachers and administrators were material (15 responses), financial (13 responses), and human resources (eight responses) as factors that contribute to or inhibit student success in STEM magnet programs.

In terms of the importance of material resources to STEM programs, T-Respondent 5 said, “keep up with new technologies.” T-Respondent 22 indicated, “adequate resources”; T-Respondent 31 said, “materials, technology”“; and T-Respondent 33 stated, “supplying students with the resources needed for the course” contribute to success. T-Respondent 51 said, “not having access to technology for learning.” One administrator, A-Respondent 31, concurred with T-Respondent 51: “Students may face challenges if they lack access to technology at home.” T-Respondent 47 was very specific about the types of material resources that STEM schools need and suggested that STEM classrooms may have “insufficient materials, [for] example, not the right kind of lab equipment, digital probes—sensors, and software.”

Several respondents highlighted the need for additional financial resources. T-Respondent 43 detailed,

> Our STEM magnet program is growing, our administrators do everything they can, but there are many budgetary constraints that jeopardize the proper progress. See, I do not understand why the district pays $4000.00 for Promethean boards for empty classrooms, while there is no budget to purchase a teaching position or supplements. Not much can objectively be expected to happen in those STEM programs.

T-Respondent 44 echoed that sentiment by stating, “The STEM magnet program at my school is great given our limited resources. I am constantly searching for free resources/software/ applications to expose my students to STEM.” Administrators also expressed the need for additional funding: “It’s also important for admin and teachers to find additional funding for the program to make it more successful” (A-Respondent 36). Additional comments such as, “Over the years the program resources have gone down” (T-Respondent 17), and “proper funding to alleviate issues with class size” (T-Respondent 40), “lack of funding” (T-Respondent 7), and “lack of funds to get the materials and equipment” (T-Respondent 42) dominated the teacher perceptions of how funding gaps negatively impacted the STEM program. Overall, teachers and administrators expressed frustration with the lack of resources.

Several respondents also expressed deficiencies in human resources as an inhibiting factor. “A successful magnet program is dependent on the teachers’ investment in their students and the program itself,” was stated by A-Respondent 24. T-Respondent 18 said, “Teachers need support from the administration.” T-Respondent 22 held, “lack of vision by administrators” as an issue. T-Respondent 10 mentioned, “lack of support from individuals who do not understand STEM” as a concern. T-Respondent 32 stated, “able to use technology necessary. Yes, the digital divide is real.” These comments reflected their perceptions on the role human capital plays in the successful implementation of a STEM magnet program.

In six instances, resources were mentioned neutrally. Respondents stated they were important but did not allude to the availability or lack of these resources. Responses such as, “adequate access to resources” and “teacher has to be a continuous learner of the vast resources available to technology teachers, which make teaching in 2020 such a wonderful and powerful career” merely affirmed that resources were important. In only one instance was the availability of school resources mentioned as a support to learning. T-Respondent 46 said,

> "Students are exposed to new resources, and most of them are based on technology, one of the most powerful for physical science is the Discovery Education Science Textbook that is a complete science basal resource designed to engage students in real-world and provides a section for each lesson that is related to elaborate with STEM. Teachers can assign projects where students clearly connect science to technology, engineering, and/or mathematics applications".

Lack of program awareness. Twenty-three teacher respondents and nine administrator respondents indicated they had no knowledge or a lack of awareness of the STEM program in their response to at least one of the four survey questions. Responses varied from "We do not currently have a STEM magnet program in our school" to "I currently teach two science courses, but these are not part of a STEM magnet program at my school." Other responses included, "I have never worked the program before, so I don't know!"; "I don't know how the program works, never been exposed to it, nor my students"; and

> "We do not offer a STEM Magnet Program; however, we do have a STEM Academy…students who want to participate in the STEM Academy must complete an out-of-area transfer or get accepted to one of our Magnet Programs (AICE, iPrep, or IT)."

Summary of Findings

The data demonstrated a relationship between graduation rates and magnet status. STEM magnet students were more likely to graduate from high school than non-magnet students meeting the same eligibility criteria. However, there was a low effect size. These data established a statistically significant interaction between the effects of magnet status and cohort year on GPA. On average, STEM magnet students earned higher GPAs than non-magnet students.

A statistically significant interaction between the effects of magnet status and cohort year on the number of mathematics courses taken beyond those required for graduation was revealed. On average, students in magnet programs took a slightly higher number of mathematics courses than non-magnet students. However, the magnitude of the difference was so small that it may not have practical significance. There was a statistically significant difference in the number of science courses magnet students took beyond those required for graduation compared to non-magnet students, but the magnitude of the difference was so small that it may not have practical significance.

Teachers’ survey responses revealed that, on average, magnet teachers had a statistically significant higher sense of confidence and self-efficacy than non-magnet teachers. Magnet teachers also had, on average, a similar outcome expectancy of students than non-magnet teachers. In addition, magnet and non-magnet teachers utilized similar number of STEM instructional strategies. Moreover, administrators reported that they were stronger in general leadership practices than in leadership for STEM.

There is agreement between teacher and administrator perceptions of factors that contribute to or inhibit student successful completion of a STEM magnet program. Additionally, this concurrence of opinions extends to what skills teachers need to teach successfully in the STEM program.

CHAPTER 5

DISCUSSION

Chapter 5 explores the implications of the study findings aligned to the research questions. The chapter begins with a discussion of the findings, followed by an in-depth review of the implications and recommendations which may impact policy and practice as they relate to the future of STEM education. This chapter also provides recommendations for future research.

Discussion of the Findings

The purpose of this mixed-methods study was to identify and explore the impact of a STEM magnet curriculum on the academic performance of participating students, compared to students not participating in a STEM curriculum. Academic performance was measured by analyzing student graduation rates and GPA. We also examined the number of mathematics and science courses students in STEM magnet programs completed as compared to the number of courses completed by students not participating in STEM magnet programs. Additionally, the study included two surveys. The teacher survey (T-STEM) considered teachers' perceptions of their beliefs and efficacy, teaching outcome expectancy, and STEM instruction. The administrator survey (P-STEM) considered administrators' perceptions of their general and STEM leadership.

Both surveys included four open-ended questions to ascertain teachers' and administrators' perceptions of the factors that contribute to or inhibit student success in a

STEM magnet program. The open-ended survey responses were revealing and provided information that clarified the quantitative findings.

Quantitative findings. The major quantitative findings follow. In particular, we focused on findings regarding relationships between STEM experiences and student achievement in its myriad forms. The findings of the quantitative portion of the study were mixed.

GPA. In this study, students in STEM magnet programs had a higher GPA compared to students not participating in a STEM curriculum. This finding was statistically significant. STEM magnet students outperformed their peers academically in all three cohort years. Moreover, although the differences were not large (magnet students earned a GPA .3 to .5 points higher than non-magnet students each cohort year), there is likely practical significance to these results, as well.

These findings were consistent with recent studies that suggest magnet students have higher achievement than non-magnet students (John et al., 2016; Wang et al., 2018). Furthermore, the findings add to earlier research that demonstrates a positive impact of magnet schools on student achievement (Ballou et al., 2006; Gamoran, 1996; Poppell & Hague, 2001; Siegel-Hawley & Frankenberg, 2011). Although our study did not specifically focus on under-represented students, other researchers have noted that STEM magnet school programs have a positive impact on student performance for underrepresented students (Scott, 2012; Young et al., 2011). STEM magnet students in the Young et al. (2011) study significantly outperformed students not participating in a STEM curriculum. The findings of our study support the notion that incorporating STEM programs in a high school's curriculum impacts student academic achievement, at least in terms of GPA. Small changes in GPA can be very meaningful and will be discussed in the implications section of this paper. We posit that this is an important finding.

Chapter 2 emphasized the need to produce college and career-ready high school students (Sublett & Plasman, 2017) followed by a STEM savvy workforce for the U.S. to remain competitive within the global economy (Hinojosa et al., 2017; Stevenson, 2014). Based on the results of this study, STEM magnet students had higher GPAs than non-magnet students. We suggest that producing STEM savvy students with high GPAs may both meet the demand for college and career-ready students and be a springboard for propelling students toward meeting workforce needs. At the same time, evaluating whether students chose to pursue post-secondary STEM education was beyond the scope of this research. This could be a topic of further research in the future.

Graduation rate. Students who participated in STEM magnet programs had a higher graduation rate than non-magnet students, but there was a small effect size. As a result, we discount the practical significance of this finding. While this finding was not significant, it is noteworthy because both groups of students had met the magnet entrance requirements. As such, academic aptitude prior to entering the STEM magnet program was equivalent.

We were unable to find specific examples of the effect of STEM magnet programs on graduation rates. However, some studies link magnets in general with graduation rates. Kemple and Snipes (2000) found that among high-risk students, those who attended magnet schools had lower dropout rates than non-magnet students. Silver, Saunders, and Zarate (2008) found that students enrolled in magnet schools were more likely to graduate on time. A study by Deming, Hastings, Kane, and Staiger (2014) looked at the impact of schools of choice on student achievement, including graduation rate. Their study did not address STEM magnets in particular, but found that choice impacted graduation rates, specifically for girls.

Although this study demonstrated a small effect size on the graduation rate of STEM magnet and non-magnet students, it is important to point out the magnet students did graduate at a higher rate. There are also multiple studies that found that magnet programs either do not affect student achievement or have a negative effect. In one study, Judson (2014) found no relationship between participating in a STEM magnet program and student achievement. Unlike our study, Judson did not specifically address high school or graduation rate; Judson's study looked at the achievement of elementary students who transferred to STEM-focused schools. In another study, Gnagey and Lavertu (2016) estimated the effect of participating in an "inclusive" STEM school on student achievement using historical student-level data from six high schools in Ohio. Overall, they found minimal or negative effects. The authors used 10th grade achievement scores as their measure of achievement. These results were consistent with other studies (Erdogan & Stuessy, 2015a; Young et al., 2011) indicating that participating in a STEM magnet school may not increase student achievement. Since we defined academic achievement to include graduation rate, our graduation rate finding is somewhat consistent with previous findings. However, in our study, we also defined academic achievement as GPA which demonstrated a positive significant effect.

Courses taken beyond those required for graduation. Students in magnet programs took a statistically significant slightly higher number of mathematics and science courses than non-magnet students. However, the magnitude of the differences in both mathematics (Cohort 1: .08 courses, Cohort 2: .03 courses, and Cohort 3: .29 courses) and science (Cohort 1: .06 courses, Cohort 2: .18 courses, and Cohort 3: .08 courses) was so small that they may not be practically significant. While their study did not directly address the effect of STEM magnet programs, Cullen, Jacob, and Levitt (2003) found no evidence that attending magnet schools affected course taking or credit accumulation.

T-STEM survey results. We asked all STEM teachers in the 12 subject schools, whether teaching in the STEM magnet program or not, to complete a 34-question survey that measured their perceptions of three constructs: Personal Teaching Efficacy and Beliefs, Teaching Outcome Expectancy, and STEM Instruction. Teachers responded to statements using a 5-point Likert Scale with responses ranging from *Strongly Disagree* to *Strongly Agree* on Personal Teaching Efficacy and Beliefs and Teaching Outcome Expectancy, and responses ranging from *Never* to *Every Time* on STEM Instruction. Magnet teachers rated themselves more highly than non-magnet teachers on each construct, although the differences in Teaching Outcome Expectancy and STEM instruction were small. Based on the results of a t-test for independent means, the differences related to Personal Teaching Efficacy and Beliefs were statistically significant. The differences in Teaching Outcome Expectancy and STEM Instruction were not statistically significant.

From a descriptive point of view, magnet teachers reported their efficacy at a much higher rate than their Teaching Outcome Expectancy. By contrast, magnet and non-magnet STEM teachers reported their efficacy and teaching outcome expectancy at almost similar levels. Figure 3 displays these results.

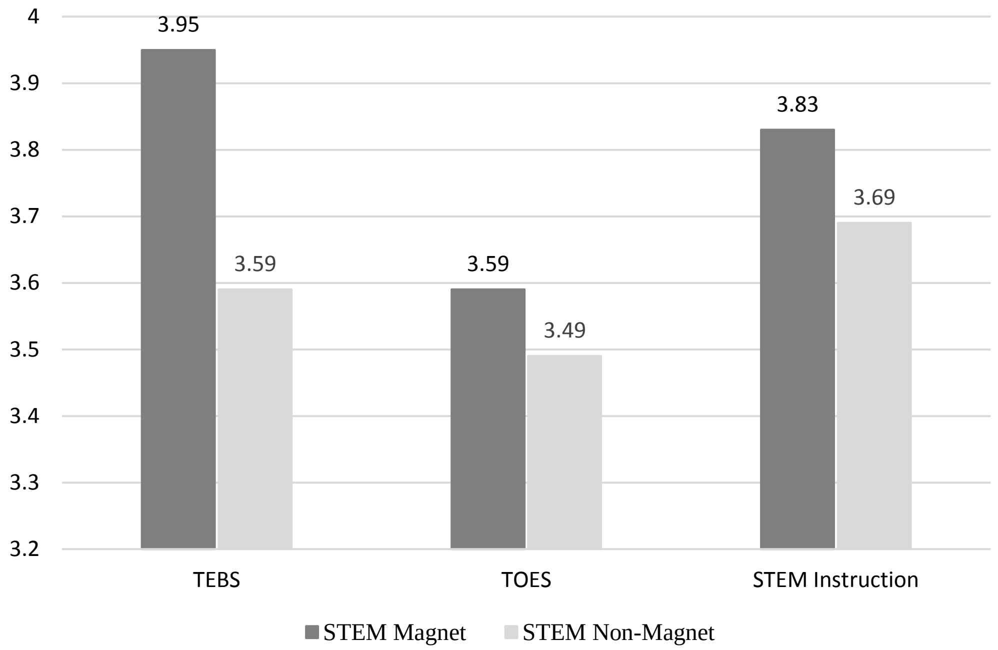


Figure 3. Mean score by construct on the T-STEM survey of STEM magnet teachers vs STEM non-magnet teachers utilizing a Likert Scale. TEBS – Teaching Efficacy and Beliefs, TOES – Teaching Outcome Expectancy. T-STEM Likert Scale ranges for TEBS and TOES: 1-Strongly Disagree, 2-Disagree, 3-Neither Agree nor Disagree, 4-Agree, 5-Strongly Agree; and Likert Scale ranges for STEM Instruction: 1-Never, 2-Occasionally, 3-About Half the Time, 4-Usually, 5-Every Time.

P-STEM survey results. Administrators in magnet schools responded to statements that measured their general leadership and their leadership for STEM education on a 5-point Likert Scale with responses that ranged from *Strongly Disagree* to *Strongly Agree*. While these results were used only for descriptive purposes, it is interesting to note that administrators rated their general leadership higher than their leadership for STEM. P-STEM had 18 items referring to general leadership and 16 items referring to leadership for STEM (Faber et al., 2015b). Nearly 92% of administrator respondents rated their general leadership as *"Strongly Agree"* or *"Agree"* on the survey.

By contrast, less than 78% of the administrators rated their STEM leadership as *"Strongly Agree*" or *"Agree"* on the survey.

Qualitative results. This portion of the study analyzed the perceptions of STEM teachers and administrators of schools with STEM magnet programs on the factors that contribute to or inhibit a student's successful completion of a STEM magnet program. Additionally, the survey examined teachers' and administrators' perceptions of the teaching skills necessary to be successful in a STEM magnet program. The qualitative portions of the surveys were analyzed using In Vivo, Descriptive, and Pattern Coding techniques. Several prominent themes emerged from the coding process: (a) Students and their affective relationship to STEM education: preparation, interest, motivation, and effort; (b) teachers' ability to deliver STEM education: pedagogy, content knowledge, and demeanor; and (c) STEM curriculum—integration, multidisciplinary approach, relevance, and application. Resources (material, human resources, financial) and a lack of program awareness were also revealed as prominent themes by the survey respondents. We counted the number of respondents who listed these factors and utilized that information to calculate the percentage of respondents who listed these factors. We also counted the number of times these factors were mentioned. The number of times the factors were mentioned exceeds the number of respondents for each factor because some respondents listed the same factors for different questions.

Students' relationship to STEM. Student preparation, motivation, and interest were identified through the survey responses to be important factors contributing to or inhibiting a student's success in a STEM magnet program. These factors were mentioned in 109 instances by 60 (61%) of the respondents. Our study revealed that teacher and administrator perceptions on a student’s level of preparation, motivation, and interest aligned with previous research and impacted their expectation of student academic performance. Helle, Laakkonen, Tuijula, and Vermunt (2013) indicated that the higher the level of preparation from a student, the higher the level of interest. Brandenberger, Hagenauer, and Hascher (2017) also found that cultivating student motivation represents a challenge, yet it is closely related to positive student educational outcomes.

Teachers’ ability to deliver STEM education. Teachers’ pedagogy, content knowledge, and demeanor were also prominent factors, as revealed by the survey. There were 206 instances where these factors were referred to by 73 (74%) of the teacher and administrator respondents. In one study, the authors found that what teachers do, how they behave, the way they design instruction and interact with students depends on their level of expertise (Keller, Neumann, & Fisher, 2016). Keller et al. (2016) also found that teacher pedagogical content knowledge influenced student learning, whereas, teacher motivation influenced student interest. In other words, a teacher who is knowledgeable and motivated may have a more significant impact on a student’s growth and learning.

STEM curriculum. Curriculum integration, a multidisciplinary approach, relevance, and application resonated with teachers and administrators as other essential factors impacting student achievement. Forty-three (44%) of the respondents identified curriculum as factors that impact student achievement. Integrated STEM education has been described to improve students’ higher-order thinking skills and technological literacy, making students better problem solvers, innovators, and inventors (Thibaut, Knipprath, Dehaene, & Depaepe, 2018). In addition, many definitions of STEM suggest that it inherently requires integration between subjects (Chiu et al., 2015; Greene, 2019).

Other factors. Human resources, material resources, and financial resources were also mentioned as factors that contribute to or inhibit student success. These factors were listed by 31 (32%) of the respondents. In addition, 21 (21%) of the respondents indicated that there was no STEM magnet program at their school, even though later in the same survey, several of the same respondents then named their school's STEM program. This resonated with us because all 12 schools in the study have had a STEM magnet program, as identified and supported by the District's office of School Choice and Parental Options, for at least eight years. The respondents' lack of awareness highlights the confusion that may exist when identifying these programs and is consistent with research that suggests that STEM is not always clearly defined. Marrero, Gunning, and Germain-Williams (2014) described the confusion that currently exists by stating that there are "muddled definitions of STEM in school settings, and ideas about what good STEM education looks like are leading to confusion and disagreement" (p. 1).

Implications for Policy and Practice

There are several important implications of the findings of this research study. Table 17 provides a statement of each finding and the related recommendations.

Table 17

Findings and Related Recommendations

Research Question	Findings	Related Recommendations
1a	The graduation rates of STEM magnet students are higher than those of non-magnet students; however, there was a low effect size.	Provide measures of accountability to ensure academic achievement from all learners.
1b	The GPAs of STEM magnet students are higher than those of non-magnet students.	Provide measures of accountability to ensure academic achievement from all learners. Invest in STEM-ready skills for elementary and middle school students.
2a	Magnet students took a slightly higher number of mathematics courses than non-magnet students; however, the magnitude of the difference was so small that it may not be practically significant.	Develop a means to encourage students to enroll in and successfully complete higher-level mathematics and science courses.
2b	Magnet students took a slightly higher number of science courses than non-magnet students; however, the magnitude of the difference was so small that it may not be practically significant.	Develop a means to encourage students to enroll in and successfully complete higher-level mathematics and science courses.
3a	Magnet teachers rated themselves higher in all three constructs studied than non-magnet teachers.	Provide professional development and develop a collaborative culture with teachers to understand how to integrate various disciplines in STEM.
3b	Administrators rated their general leadership higher than their leadership for STEM programs.	Provide professional development for administrators to prepare them to provide strong leadership for STEM.
4	Five themes emerged from the data: Students and STEM; Teachers ability to deliver STEM education, STEM curriculum, Resources, and a lack of Program Awareness.	Clearly define STEM education, focus curricular direction, and provide a clear strategy for STEM education. Provide professional development and develop a collaborative culture with teachers to understand how to integrate various disciplines in STEM.

Note. STEM = Science, Technology, Engineering, and Mathematics; GPA = grade point average

College admissions. The GPA of students in all three cohorts analyzed in the study was higher for STEM magnet students than for non-magnet students. A study conducted by Horn and Flores (2003) on college admissions demonstrated that a small change in GPA can have significant consequences, especially in state universities using a high school rank or GPA threshold for automatic admission or disqualification. Based on the State University System of Florida, the average GPA requirement for acceptance varies widely. The difference between the GPA required for admission to the University of Florida versus Florida State University is 0.1 of a GPA point (Appendix L). In Florida, there is also a scholarship program (Florida Bright Futures) with minimum GPA requirements (Appendix M). Students with a higher GPA are eligible for a larger scholarship amount. Additionally, some studies highlight the effects of small GPA differences. In one study, students who barely qualified for admission to four-year public colleges in Georgia and Florida tended to graduate college at higher rates (Goodman, Hurwitz, & Smith, 2015). In another study, students who barely qualified for admission to four-year colleges earned substantially more later in life than otherwise similar students who barely missed qualifying (Zimmerman, 2014). Based on this research, STEM magnet students may have a distinct competitive advantage in being admitted to a college or university. As such, the successful completion of a STEM magnet program may serve as a practical option in preparing students for college and generating graduates who are more attractive to university admissions officers who are selecting candidates for admission to their universities.

Student preparation for STEM magnet high school programs. Teachers listed student preparation and prior knowledge of the subject matter as contributing or inhibiting factors to students’ successful completion of a STEM magnet program. Therefore, an implication of these perceptions is that the level of academic preparation students receive before entering high school is a critical component in students' future success. One respondent indicated "student's ability to handle course load" (T-Respondent 17). Another wrote "strong math skills. Strong reasoning and critical thinking skills. Strong problem-solving skills" (T-Respondent 38). "Prior knowledge base" (T-Respondent 18) was another teacher response. The teacher responses suggest that teachers perceive that students must have a strong academic foundation to be successful before being enrolled in a STEM magnet program. Teachers' perceptions on the T-STEM survey repeatedly emphasized that student preparation is vital for the rigors associated with a STEM curriculum.

The findings of our research study concluded that the difference in the number of courses taken beyond those required for graduation by students in STEM magnet programs compared to non-magnet students was not practically significant. Our research had similar findings to results of a study conducted by Cullen et al. (2003), which found no evidence that attending magnet schools affected course taking or credit accumulation. Taking a longer view of the effect of STEM courses, in a study of 40,000 students studying at 39 colleges, students who had taken rigorous STEM college-level courses in high school had an increased tendency to major in a STEM field (Mattern, Shaw, & Ewing, 2011).

Conversely, a longitudinal study of middle school students conducted in North Carolina investigated if STEM programs increased the number of students majoring in STEM college programs. There was no evidence that attending high schools with a STEM program significantly influenced the trajectories of STEM educational advantage for public school students. The study concluded that success in STEM college programs has more to do with what happens before entering high school (Bottia, Stearns, Mickelson, & Moller, 2018). Given the results of this research and our findings, we propose creating a STEM-rich middle school experience within the feeder patterns of the 12 subject schools. This may create a pipeline of well-prepared students with strong STEM skills that can lead to these students selecting and successfully completing a high school STEM magnet program and possibly continuing to pursue a STEM field in their post-secondary studies.

Student success in STEM magnet programs. Teachers' beliefs and perceptions on the constructs examined in this study indicate that there is a need to further develop concepts that are integrated into teaching STEM courses. Research indicates that schools that deliver quality STEM instruction have teachers who understand that their beliefs are related to student development (Margot & Kettler, 2019). A systematic literature review found that STEM teachers' prior views and experiences with STEM are as crucial to students' development as the STEM instruction they deliver. Margot and Kettler (2019) reviewed and coded 25 articles and identified several common themes within the data. They found that teachers value STEM education, but they reported significant barriers such as pedagogical, curriculum, and structural challenges, concerns about student preparation, concerns about assessments, and lack of teacher support (Margot & Kettler, 2019). Teachers also reported that support would significantly improve their efforts to implement STEM education. These included quality curriculum, peer collaboration, effective professional development, and district support. In our study, T-STEM survey responses mirrored the findings of Margot and Kettler's (2019) study, supporting recommendations to review professional development and support for teachers, including pedagogy, curriculum, and best practices for the integration of STEM fields within the classroom.

In our study, magnet teachers listed themselves as a major factor contributing to a student's success. The responses can be generalized under teacher preparation, and more specifically, teachers who had strong content knowledge and possessed the ability to use application in their instructional delivery. Among the responses listed by teachers, "teachers who use applications instead of just pure theory" (T-Respondent 23), has implications for teacher professional development. If teachers perceive the importance of providing students with a robust set of experiences that apply to the subject being studied, teacher professional development can be adjusted to provide teachers with the necessary training to ensure that application plays a significant role in their instruction. Capraro and Slough (2013) advocated providing students with meaningful learning experiences that connect disciplinary knowledge with real-world experiences. This suggests that school districts that seek to improve on students' successful completion of a STEM magnet program should consider realigning their teacher professional development to support the use of real-world applications into their teaching practices. As such, M-DCPS should consider aligning its professional development to specifically account for teacher STEM learning opportunities within STEM magnet programs. These learning opportunities for teachers should specifically focus on integrating a hands-on, interdisciplinary, STEM learning experience through a well-defined STEM course of study. Weiman (2012) indicated that teachers spend too much class time with students engaged in passive activities such as listening and using specific methods to practice new skills. Neither of these strategies consists of the required cognitive components "nor require the level of strenuousness that are important in learning" (Weiman, 2012, para. 14). The use of real-world applications suggests there is no room for passive learning activities in a classroom.

Definition of STEM education. According to the National Academy of Engineering and NRC (2014), STEM education is not a well-defined experience, and its definition is an area of great confusion. Responses from our study demonstrate that teachers and administrators are not fully aware of what constitutes STEM. As such, it is apparent that there is a need to standardize a clear concept of what STEM education is. T-STEM and P-STEM survey respondents had difficulty recognizing the presence of a STEM magnet program in their schools. However, all respondents worked in schools with a STEM magnet program identified by the Office of School Choice and Parental Options based on the magnet program offerings in the subject schools. This finding implies that teachers and administrators lack program awareness of STEM magnet sub-themes, as identified by the Office of School Choice and Parental Options (M-DCPS, 2017), and may require additional marketing and leadership training. Moreover, all the teacher respondents were STEM teachers, and it follows that they should know what it takes to be a successful STEM student, whether in the magnet program or not. These findings are concerning given the District's investment in STEM programs and emphasis on promoting school choice.

Curriculum integration. The curriculum is another area where implications can be drawn based on teachers' responses regarding the factors that contribute to a student's successful completion of a STEM magnet program. Teachers' responses on the T-STEM survey identified an implication to align and integrate STEM curriculum. Teachers' responses varied. One teacher’s response indicated “being able to relate all subjects together” (T-Respondent 14), while another identified “cross-curriculum that is both engaging, rigorous, and relevant to students” (T-Respondent 39) as important factors. It is easy to find research that support these teachers’ views. Mohr-Schroeder, Cavalcanti, and Blyman (2015) described STEM integration as one of the best chances to provide learning opportunities in real-world situations, as opposed to learning in a piecemeal manner that requires assimilation later. Curriculum integration is a consequence of an educator’s cognizance that real-world applications are not isolated into individual disciplines but rather the application of those disciplines to real-world problems (Czerniak, Weber, Sandmann, & Ahern, 1999).

To support teachers in integrating STEM across the curriculum, professional development opportunities should be afforded to teachers so they may comfortably make this paradigm shift and leave behind the isolationism that currently exists. Chiu et al. (2015) suggested that “the basis of STEM education involves [the] integration of these [STEM] subjects by breaking down the silos of discipline-independent teaching that students often encounter” (p. 3). School districts that best align their curriculum and provide teacher training on multidisciplinary instructional delivery methods will be best prepared to provide its students with opportunities for success.

Recommendations

The effect of STEM programs on the economic viability of the U.S. dates back to the 1870s and continues to be significant today. Many jobs in the 21st century require some level of STEM knowledge, and a great number of jobs rely deeply on knowledge-and-technology-intensive industries (NRC, 2011). STEM employment has grown more than twice as fast as other fields during the last decade, and the need to produce new scientists and engineers in the U.S. continues to grow if we are to remain competitive in the global marketplace (Hrabowski, 2012; U.S. Department of Labor, 2007). As such, the recommendations in this section are based on the premise that the U.S. must continue to do more as a nation to improve the quality of K-12 STEM education.

The purpose of the recommendations in this section is to propose a starting point for actionable practice to reinforce and deepen learning for all stakeholders and enhance the delivery of the curriculum in STEM magnet programs. In educational reform, the synergy of the process is critical in obtaining sustained positive results (Fullan, 2007). Therefore, it is recommended that the vagueness of STEM education be addressed to develop an appropriate curriculum and address the need for professional development in the area of STEM.

After careful analysis of the data gathered from the research questions and the extensive literature examined in this study, the implications for policy and future practice can be made actionable by using Fullan and Quinn’s (2016) Framework of Coherence. It is also essential to recognize the need for change in addressing this systemic problem. Actionable goals would address the implications in this study: (a) clearly define STEM education, focus curricular direction, and provide a clear strategy for STEM education; (b) provide professional development for teachers and administrators, and develop a collaborative culture with teachers to encourage them and help them understand how to integrate various disciplines in STEM; (c) develop a means to encourage students to enroll in and successfully complete higher-level mathematics and science courses; (d) provide measures of accountability to ensure academic achievement from all learners

(Fullan & Quinn, 2016); and (e) invest in STEM-ready skills for elementary and middle school students.

Clearly define STEM education, focus curricular direction, and provide a clear strategy for STEM education. There are numerous definitions of STEM. Mohr-Schroeder, Cavalcanti, and Blyman (2015) provided a definition that took into account project-based learning and closely aligned to T-STEM respondents' perceptions of factors that lead to student success in STEM education.

> STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy. (p. 10)

M-DCPS, as part of its longstanding commitment to school choice, offers an extensive array of STEM programs, with varied themes. Many of these programs are marketed by the schools based on their theme rather than their specific connections to STEM. Additionally, schools are provided with great latitude on the courses offered in their respective STEM programs. The District, however, clearly labels and markets these programs as STEM programs without much detail. This may explain why some survey respondents expressed a lack of awareness of the STEM program in their school. Utilizing the concept of coherence, there is work to be done to ensure that schools and the District market these programs similarly. Moreover, there is a need for a specific course of study for each program accompanied by a scope and sequence for each corresponding course within the program. Creating a structured alignment of courses will eliminate the ambiguity that currently exists. This will lead to a universal expectation for each program while continuing to allow schools to exercise flexibility in marketing their STEM magnet programs.

STEM programs also vary in their implementation and design~~s~~, providing a muddled view and creating confusion over STEM program content. Curricular alignment bridges gaps between design intentions and the use of curriculum to achieve an educative purpose. As such, we recommend the implementation of Project-Based Learning (PBL) as a foundational approach to STEM education. PBL reinforces mathematics and science curriculum and concepts; the focus is more on the process of learning and learner-peer-content interaction than the end-product itself (Edmunds et al., 2017). PBL is authentic hands-on experiential learning based on the student's knowledge that requires teacher guidance and subject matter conceptual knowledge and allows students to make decisions that guide the research in developing a product. PBL is also consistent with the definition of STEM that requires an interdisciplinary and applied approach.

Many current federal Magnet Schools Assistance Program grant requests for proposals include PBL as a primary strategy for delivering STEM instruction (https://msapcenter.com/). In many U.S. high schools, the most common form of PBL exists in after-school computer groups, robotics clubs, and competitive mathematics and science teams (Atkinson & Mayo, 2010). However, PBL must be embedded in all aspects of STEM instruction.

Moore et al. (2014) conducted an extensive review of published literature that explored how teachers deliver STEM education in their classrooms. The researchers identified six significant components for quality K-12 STEM education design: (a) the inclusion of math and science content, (b) student-centered pedagogy, (c) lessons situated in engaging and motivating context, (d) inclusion of engineering design or redesign challenge, (e) students learn from making mistakes, and (f) teamwork is emphasized. We recommend utilizing this framework to ensure a cohesive and clear strategy for STEM education. This framework aligns with the concepts of PBL.

Provide professional development for administrators and teachers and develop a collaborative culture with teachers to encourage them and help them understand how to integrate various disciplines in STEM.

Administrators. When indicating their agreement with STEM leadership statements on the P-STEM Survey, 78% of the administrator respondents selected *Strongly Agree* or *Agree*, compared to 92% who responded similarly to statements regarding their general leadership skills. Therefore, we recommend providing additional professional development for administrators to support them in developing their STEM leadership skills and in recognizing, developing, and capitalizing on the leadership of teachers they supervise.

Teachers. M-DCPS has fostered the rapid growth of school choice, therefore, the District must continue to focus on innovation and the improvement of teacher practice. Collaboration with purpose and equity must also include components of excellence and accountability for curriculum offerings (Datnow & Park, 2019). Consistent with Mohr-Schroeder et al.'s (2015) definition of STEM education, we recommend additional professional development for teachers and administrators that concentrates on pedagogical practices that include an interdisciplinary and applied approach to STEM education. By including both teachers and administrators, there is a greater opportunity to have coherence and to ensure that all parties understand what this approach is and what it looks like in the classroom. We also recommend follow up and job-embedded professional development that supports teachers in their classrooms.

Although there is significant research on teacher communities and teacher collaboration in the context of the school and professional learning communities, the focus is mostly on the forming of communities and the teachers' learning process, not the content (McLaughlin & Talbert, 2001). Professional learning communities (PLCs) are essential; however, there is a significant need for these communities to focus on content to facilitate the integration of the various STEM disciplines. Some PLC activities focus on student work but still fall short of addressing integration. We recommend the formation of PLCs, focusing on the integration of STEM content.

Develop a means to encourage students to enroll in and successfully complete higher-level mathematics and science courses. In our study, magnet students had higher GPAs than non-magnet students. While the scope of this study did not include examining the specific reasons leading to higher GPAs, there are possible explanations. It is possible that magnet students earned higher grades than non-magnet students. Alternatively, in this study, we compared weighted GPAs. Therefore, it is plausible that magnet students enrolled in a greater number of advanced courses, providing them with opportunities for higher weighted GPAs than non-magnet students due to bonus points. According to Byun, Irvin, and Bell (2015), taking advanced math courses has positive effects on math achievement and college enrollment. Furthermore, the College Board reported several positive effects of students passing AP Exams with a score of 3.0 or higher: (a) AP students had higher on time graduation rates (Mattern, Marini, & Shaw, 2013); (b) AP students had statistically significant higher GPAs (Murphy & Dodd, 2009); (c) AP students, especially STEM students, were more likely to pursue college majors in their AP subject (Mattern et al., 2011). These studies confirm the advantages of taking advanced coursework.

To assist in meeting the call for a STEM ready populace, we recommend that school districts review and assess their curriculum maps for mathematics and science progression and provide equitable opportunities for all students to take appropriately challenging advanced-level course work. This recommendation is based on research that suggests that successfully completing advanced coursework leads to greater academic success. According to Dougherty, Mellor, and Jian (2006) under-represented students who earned a score of 3 or higher on at least one AP Exam were more likely to graduate from college than students not taking AP courses. Student services personnel play a critical component in ensuring that all students have access to suitable accelerated courses. By exposing students to challenging coursework, schools provide opportunities for students to be engaged in more in-depth learning.

Provide measures of accountability to ensure academic achievement from all learners. Given the rapidly changing technological landscape and the significant investment in STEM education, we recommend conducting periodic evaluations of STEM initiatives to identify successes and opportunities for improvement. In addition, schools must develop continuous and interactive assessment techniques so that testing becomes a tool for learning in STEM Programs. Ensuring access to educational experiences in STEM education also includes providing time within the school day, extended periods, or flexible scheduling models to accommodate extra courses (Atkinson & Mayo, 2010). There is an inherent need to review state graduation requirements, required testing, and school accountability plans to reduce the impact of school accountability and grading; this is not an easy task when faced with the high stakes of school grading pressures.

In Chapter 4 of this study, we noted that half of the target high schools offered an eight-period schedule while the other half offered only six. The accountability implications are that students with eight-period schedules had the opportunity to take eight additional courses during their high school years, possibly providing them a greater course accumulation and GPA advantage. Although this was not within the scope of this study, exploring the effects of a six-period schedule compared to an eight-period schedule on the achievement of STEM magnet students may be an area for future research.

Invest in STEM-ready skills for elementary and middle school students. The results of our study are mixed. Therefore, we strongly support the idea of investing in STEM-ready skills for elementary and middle school students. This will strengthen and enhance the current STEM educational experience. Currently, the thrust in STEM education is taking place at the high school level.

> According to the National Science Board’s Science and Engineering Indicators 2018, Americans’ basic STEM skills have modestly improved over the past two decades but continue to lag behind many other countries. According to the Indicators, from 2006–2015, American 15-year-olds still tended to score below the international average in mathematics skills, and at or slightly above the

> international average in science skills. Recent data from a test commonly taken by college-bound high school students found that only 20% are ready for courses typically required for a STEM major. (National Science and Technology Council, 2018, p. 2)

According to Vilorio (2014), STEM-ready skills include critical and creative thinking skills and strong communication skills, including writing, speaking and interpersonal communication skills. STEM-ready skills also include problem solving, collaboration, inquiry, and mathematics and science skills. A realignment of current STEM learning should include developing these skills beginning in the primary grades and growing more in-depth at the middle school level to establish a solid STEM foundation. This would allow students in high school to be more prepared for the rigors of a comprehensive STEM program which may lead to more students seeking post-secondary STEM career paths. Moreover, this would provide an opportunity to chart a new course to regain our global status as the world's leading educational system.

In addition to the potential impact of increased STEM learning opportunities at much younger ages, investing in STEM is an economic imperative. It is a national priority in the U.S. (National Science and Technology Council, 2018). The improvement of existing or the creation of entirely new products, processes, services, and business or organizational models, which drives economic growth, competitiveness, and quality-of-life improvements for all citizens, rests on STEM innovation. Science and technology-based innovation are impossible without a workforce educated in science, technology, engineering, and math. Continued national investment in STEM education, beginning at the elementary level, will benefit students and prepare them for success in the global economy that is becoming increasingly reliant on technology and innovation.

Federal strategic plans and reports have emphasized the importance of STEM education to attain national goals in the areas of national security, artificial intelligence, cybersecurity, quantum information science, and advanced manufacturing. STEM education continues to be a priority for the U.S. and school systems implementing STEM programs (Atkinson & Mayo, 2010). Building a bank of individuals capable of developing and keeping up with current and future scientific advances will help meet the call for a STEM-literate society in the U.S.

Recommendations for Future Research

Several areas for future research may add to the findings of this study. Future significant research topics include:

1. We recommend utilizing PBL as a foundational curricular and pedagogical practice in STEM education. Therefore, future research may include investigating whether participating in science, technology, engineering, and mathematics PBL activities affects students of varied performance levels and to what extent these practices impact mathematics and science achievement.
2. We recommend implementing STEM education in the primary and middle grades. Therefore, a longitudinal study investigating if students participating in STEM education in Grades K-12 choose a post-secondary course of study in a STEM field may add to this study.
3. The teacher and administrator survey responses identified a need for an interdisciplinary and applied curricular approach to STEM education.

Therefore, further research in curricular design of teacher teams within schools and the activities and conditions that lead to successful collaborative practices in the implementation of an interdisciplinary and applied curricular approach may add to this study's findings.

4. This study did not measure the GPA difference between students with a six-period schedule and those with an eight-period schedule. Future research may explore the impact of course accumulation on GPA based on an eight-period schedule versus a six-period schedule.
5. We found a statistically significant GPA difference between magnet students and non-magnet students. However, it was beyond the scope of this research to determine the cause of this difference. It is possible that the GPA difference was due to magnet students earning better grades in the same courses. It is also possible that the GPA difference was because magnet students took more advanced, AP, IB, and/or dual enrollment courses than non-magnet students took and received bonus points for those courses. Further research on the reasons for the GPA difference could add to this study.
6. Although our study focused on STEM programs, Miami-Dade County Public Schools has also implemented STEAM programs that incorporate the arts. STEAM is the acronym for Science, Technology, Engineering, Art, and Mathematics. These programs integrate STEM with the arts. One area for further research may be to conduct a study comparing the impact of STEM versus STEAM programs on student achievement.

Summary

Results from this study are mixed and indicate that students who are part of a STEM magnet program outperformed their peers at the same school in grade point average. While magnet students' graduation rate and the number of mathematics and science courses successfully completed exceeded those of non-magnet students, these differences were either very small or not statistically significant. The study also reported teachers' and school administrators' agreement with groups of statements that measured teacher efficacy and beliefs, teaching outcome expectancy, and STEM instructional practices, on a 5-point scale from *Strongly Agree* to *Strongly Disagree*. While only teacher efficacy and beliefs differences were statistically significant, it is interesting to note that most teachers surveyed rated their agreement or strong agreement with each of the three constructs (Teaching Efficacy and Beliefs: 67.4%; Teaching Outcome Expectancy: 50.7%; and STEM Instruction: 69%).

The study also analyzed teachers' and administrators' perceptions of factors that contribute to or inhibit students' successful completion of a STEM magnet program. The survey respondents identified students, teachers, and the curriculum as factors in students' success. Student preparation, motivation, and interest surfaced as important factors. Additionally, teachers' pedagogy, content knowledge, and demeanor also played an important role. Finally, the integration of curriculum, utilization of a multi-disciplinary approach, relevance, and application of the curriculum resonated with teachers and administrators as critical factors to students' success. Survey respondents also noted resources and a lack of awareness of STEM programs as important factors.

This study demonstrated that students in a STEM magnet program had higher GPAs. This academic factor provides students with a distinct competitive advantage in gaining admissions to colleges and universities. Student preparation is critical to the success of students in a STEM program. Perceptions from teachers and administrators support the idea that the more prepared a student is when entering high school, the more successful the student can expect to become. The study also revealed implications for curriculum development, specifically in the areas of curriculum integration, and the use of an applied approach. The integration of mathematics and science while using technology and engineering concepts will provide clarity and support a standard definition of STEM programs.

CHAPTER 6

PROFESSIONAL REFLECTIONS

This dissertation was the result of a group effort and this final chapter provides individual professional reflections on the leadership transformation that each of us experienced as we completed the dissertation and how the group process contributed to our professional and educational growth. The personal reflections are presented in alphabetical order by the last name of each group member.

Eric Acosta

Leadership transformation. The William & Mary Executive Educational Doctorate program has provided me with an expanded frame of reference in my role as an Administrative Director in the Miami-Dade County Public Schools' Central Region Office. Wheatley (2006) suggests that the real world requires obedience and efficiency to solve problems within organizations. There are many times that in making sense of intentional chaos to reform a process, leaders need information and the discomfort that the information brings to reach a place of clarity. There are times when leaders no longer know what works, that their model, their frame for organizing the problem or organization requires change. This program further developed my leadership and decision-making skills to deal with the challenges that range from unexpected crises to well-thought-out strategic interventions.

During this program of study, I have learned that an effective leader needs to balance the moments when one follows procedures and the instances in which one takes the initiative and provides solutions. One size does not fit all. I considered myself a transformational leader at the beginning of this process, and today, I have better developed the necessary skills to support the schools assigned to me. I believe this program refined my questioning skills when examining problems. I have learned to better understand concepts and investigate by reviewing research and adapting information to the current situation or reality. As an avid consumer of research, I can provide principals, students, and parents with research-based practices. This program has sharpened my ability to think critically and to arrive at win-win solutions for all stakeholders, which is of paramount importance in my position. I can accomplish this by applying ’others’ research to real-life events.

My ability to cope with chaos forces me to understand what truly motivates people and that we adopt strategies that lead to order, not more chaos (Wheatley, 2006). As an administrator in a large school system, I understand that chaos is inevitable and sometimes necessary for the evolution of those within the system. In a sense, as a district leader, I am a ‘principal’ for all the principals I supervise. No matter how proactive I wish to be, their crisis is my crisis. Principals will generally grow and continue their personal growth if I motivate them and develop relationships with them. Fundamentally, this is no different than the reason that students learn from their teachers. This doctoral program has reminded me to reflect on the formative feedback process, observing teaching, and my supervisory style (DiPaola & Wagner, 2018). Refining and mastering my supervisory style is of great importance and affects my professional work in the field with principals.

I strive to be an inspirational leader who assists others in finding their ""Why"" (Sinek, Mead, & Docker, 2017). I believe that as my professional responsibilities expand, I will be able to use the processes learned throughout the doctoral program. I am continually refining my leadership skills to positively impact all schools within my scope of supervision.

Collaborative scholarship. Deciding on a problem of practice in a district where school choice is essential to the Superintendent's vision was not difficult. Magnet programs within our traditional schools affect the whole school environment, the work we accomplish, and personnel we supervise. My cohort colleagues and I shared common interests in researching the effectiveness of Magnet STEM programs. I felt this was a viable option for a problem of practice. I also felt that examining our district's magnet programs aligned well to the District's mission in terms of both curricula as well as return on investment. The heightened emphasis on STEM due to the need for a college and career-ready workforce at the national level seemed like a natural fit for our study. I proposed that we focus on STEM magnet programs and their impact on student achievement. The group had different perspectives about how to approach the research questions initially, yet we all worked in unison to ensure that we reached the right set of questions after we decided what problem to investigate. We collaborated on an ongoing basis in meetings, virtual meetings, and other communication forms to discuss the research and the impact of STEM magnet programs on student achievement.

The challenges presented in interpreting the data or research findings during the study were dealt with through constant communication. Our team held almost all our meetings face to face at least twice per week. If a team member was unavailable for some reason, the rest of us met anyway. Our regular meetings kept the work, and the thinking, moving forward at all times. While all the ideas presented were good ones, the main argument, and common theme for selecting a study about STEM magnet school programs was the significant investment in and attention our district has placed on this option of school choice along with its impact on student achievement.

During previous class assignments throughout the program, I made decisions to self-pace, whereas the research team worked well by pacing ourselves based on weekly and monthly tasks. It was no longer about deciding alone but taking into consideration the entire team's opinion on how to proceed when a challenge presented itself. Being a member of a research team, I believe we all learned that having to explain the thought process made us all better learners and collaborators. The opportunity to collaborate, learn together, and build on each other's skills and strengths made us all better researchers and allowed us to develop a detailed final product. Collaborative work throughout the dissertation study provided me with a different lens, as my colleagues shared their professional experiences. Being part of a dissertation group was a critical reminder of group accountability and the value, and power of collective voice.

Evonne S. Alvarez

Leadership transformation. The experience of pursuing a doctoral degree in education provided me with an expanded frame of reference because it is more than the pursuit of a degree. The process of becoming a determined and knowledgeable researcher was essential training, which resulted in a continual progression of reading and analyzing information that improved my professional thought process. I have a new lens, which has given me a different perspective on the way I read for information, collect data, analyze data, and make decisions that impact students district-wide.

As a consumer of information and research, gathering facts and perspectives from a wealth of sources is part of a thought process. I have an explicit understanding of student achievement data, the ability to identify problems within the instructional program based on data, and a different perspective on closing the achievement gap through program evaluation. Throughout the study, as data were collected and reviewed, examining literature became essential to making connections and developing adequate solutions for the problem. After the study, it became clear how identifying relationships between the results and the district's work should be designed.

My collective administrative experiences in secondary schools remind me that supporting student services was a critical component of providing equity and access for all students. Access for all students would dictate that they are placed in the courses that would best prepare them for the world of work, college, or both. Darling-Hammond (2010) makes a point of identifying the anatomy of inequality. She asserts that there are several ingredients to dismantling inequality. They include leveling the playing field with resources, molding educators' perceptions and behaviors, high expectations for students, and providing strong supports within the educational environment. The descriptive analysis of the study reinforced that these themes are surfacing in our schools given the statements from both teachers and administrators that express concern over resources, academic guidance, and student preparedness for rigorous courses.

The research process enhanced my awareness of the type of leader I considered myself to be before the program and my professional growth cycle after the process. Reflecting on my experiences as a leader, Northouse's (2016) five characteristics of authentic leaders best describe my leadership style:

> (a) They understand their purpose, (b) they have strong values about the right thing to do, (c) they establish trusting relationships with others, (d) they demonstrate self-discipline and act on their values, and (e) they are passionate about their mission. (p. 211)

The value of the research and the results of the study are guiding points within the scope of my work in the Office of School Choice and Parental Options.

In *The Flat World and Education: How America's Commitment to Equity Will Determine Our Future*, Darling-Hammond (2010) deliberately discusses the impact of poverty on education. In her book, Darling-Hammond developed a coherent set of policies that can be used to create high-quality and equitable schools. This part of our course work resonated with me as a leader because I believe I have a responsibility to address equity, diversity, and the lack thereof, in schools. As we filtered through data, analyzed the outcomes, and wrote responses to the research questions, I was confident that I was in the right field of education, supporting the development of new and innovative programs to provide equitable educational opportunities to all students. The experience as a researcher supports my thought process regarding providing new opportunities to increase equity and access for students in magnet programs and non-magnet programs alike. The concept of equity is embedded in many educational objectives within the 'District's strategic plan. As a leader, this program has enhanced my capability to impact academics and the learning environment and close the student achievement gap. Applying the theoretical concepts learned throughout the three years of this program to a study and taking the analysis of problems in our field from theory to the concrete with in-depth analysis was a personal strength. It is necessary to examine the goals of the District with deliberate attention to equity and access to address the achievement gap, but also because it is ethically wrong to ignore disparities in educational services within our communities.

Equity consciousness is defined by four truths: all children can achieve at high levels; all children includes those of varying races and socioeconomic status; the school community is responsible for educating all children; and not all students learn in the same way and therefore may require untraditional practices to narrow the achievement gap (Skrla, McKenzie, & Scheurich, 2009). Equity in education remains a highly sensitive topic. However, this program well equipped me to discuss and support this topic in local and national conversations. It is time to celebrate diversity and leverage these relationships to energize our District, schools, and the local community (Wheatley, 2006).

Collaborative scholarship. Our research team identified a problem to investigate through multiple professional conversations concerning what we wanted to know about students in STEM magnet programs. The research method was a challenge before the defense proposal because we were initially conducting a cross-case analysis with both quantitative and qualitative data. After much consideration and discussion with Dr. James Stronge and Dr. Thomas Ward, we changed our approach to Explanatory Mixed-Methods, with a heavy focus on the quantitative data. The qualitative data were used to help make sense of the quantitative data. The challenges outside of the research itself, such as defining consistent times to work together and overcoming personal struggles we all faced at different times, made us a cohesive group. We worked well together and became acutely aware of the individual strengths each researcher brought to the group. The group worked collectively to conduct the research and met regularly two to three times a week for the past year. We used a systematic process in which we worked together, interdependently, to analyze and impact professional practice to improve our individual and collective results (Fullan, 2011).

The biggest challenge we faced was conducting the analyses for courses taken above and beyond those required in mathematics and science. The data we received from the District reflected all of the coursework for all students in the schools that were the subject of our research, and it took several weeks to filter and process the information on students that graduated with alternate pathways as well as those who disappeared from the cohorts before graduation. As we moved through the process of being individual learners to a research team, the group study time proved to be beneficial in improving our thought process and moving us forward as we agreed and disagreed in how to approach questioning the data, understanding the research, and discussing the problems we encountered throughout this research journey. I continued to make connections to prior readings, as we learned throughout the final steps of the dissertation process. Wheatley (2006) discusses how vision is a field brought forth by the leader, and those within the organization begin to build capacity and purpose of the organization; eventually, that field starts to influence their behavior. This is the best way I can describe the intended consequence of the doctoral program.

The District's vision of investing in the cohort as a group of leaders was intended to develop a group of critical thinkers and researchers that would continue to approach problems of practice in the same manner. To be successful as we tackle complex projects, it is necessary to research relevant literature, conduct research, and develop strategic plans to address problems of practice in professional group settings.

Gilberto D. Bonce

Leadership transformation. As an educational leader, this experience has trained my habits of mind when I seek the answer to a professional problem. Specifically, from the inventory of Habits of Mind, I can identify with several skills that this doctoral program helped me refine. These skills include persisting, thinking flexibly, questioning, posing problems, striving for accuracy, and precision **(**Costa & Kallick, 2008).

Wilson (2004) and Kahneman (2015) shed light on an arena I had not been previously mindful of, such as the adaptive unconscious, systems of thinking, and the outside view. After reading their work, I have been cautiously reflective of my actions and the perceptions others have of me. I have acquired an approach to analysis that focuses on the way that interrelationships exist between a constituent's parts, and how systems work over time and within the context of larger systems (Wilson, 2004). This ability to understand how systems work is a needed leadership skill I refined during the dissertation process.

The experience of engaging in the doctoral program supported my critical thinking skills and trained me to be detailed and thorough in my professional outputs. Through ongoing readings and digesting research on all aspects of being an instructional leader, I have become savvy as a consumer of research. When I reflect on the next step in my professional career, I look forward to opportunities that bring me closer to data analysis, supporting principals as a region administrator and researching problems of practice for the district. My experience with this dissertation study is that data research should be fully integrated into all practices in district offices. The program of study developed and strengthened many aspects of my role as a leader. I am a transformational leader and adapt authentic and servant leadership styles as required by the work. I believe the essential characteristics of my leadership style are evident in my daily work and that I have uniquely blended several leadership styles (Northouse, 2016).

Collaborative scholarship. There are many rewards to working as a group. The identification of the problem was not as difficult and challenging as identifying the appropriate research method. Essentially, we began our process with a Mixed-Methods, Cross Case Analysis. After much deliberating, and with guidance from our dissertation chairpersons, we shifted to an explanatory mixed-methods approach. We refined the process of the data collection and data analysis for both Chapters 3 and 4.

The shift from being individual members of a cohort to a research team was not a complicated process. It provided me with additional insight into the strength of the specific members of the group. Although I knew all my colleagues in a professional setting, professional conversations allowed us time to collaborate on the current district reality; questions we each collected about the effectiveness of STEM programs helped us refine the problem to investigate.

The lessons learned are that we all need time as professionals to engage in continuing education to reenergize ourselves and develop our professional strengths. A recommendation for subsequent cohorts who investigate complex projects is that they should understand that such investigation requires extensive collaboration on the part of all professionals. Each member should have experience and contextual knowledge in the area to investigate. In our dissertation group, all of us had secondary school principal experience, four of us have been high school principals, and two of us have a strong mathematics and science background. One district administrator has extensive experience in secondary curriculum and magnet programs, and the other two district administrators are in supervisory positions, which require a wealth of knowledge about systems within M-DCPS. The group was well balanced in terms of experience although this was an unintended consequence of the dissertation grouping. The group process is a model that can be used in our professional settings to investigate problems in our field.

Melanie E. Megias

Leadership transformation. This program expanded my frame of reference as a leader and refined my habits of mind. I am a linear thinker and a didactic writer, yet this program of study allowed me to further hone my everyday thought process. As I consider the Habits of Mind, several of them apply to the way I work, and the approach I took to our group work. First, “Striving for Accuracy” is a core principle that guides my work. Early in my career when one of my bosses described me, she said my attitude was one of, “If you’re going to do something, you may as well do it right.” Her assessment was right on target. I learned through the dissertation that this guiding principle is a strength but can also be a weakness at times. Even though our group met often and reached consensus on everything, I found myself at home reviewing the data again, double-checking what we had done. My practice was helpful, but I did not always reach new conclusions. "Persisting" is another habit of mind that resonates with me, and I think it resonated with our entire group. Despite personal and family challenges that each of us faced during this process, we all persisted. We worked through the things we could, we supported each other, and we worked around the challenges that we could not overcome. During the dissertation process, persisting helped us when we approached our work one way, met challenges, and devised alternate paths to finding solutions. We did not give up! "Thinking about Thinking," or metacognition, also played an essential role in the dissertation process. We had a plan of action from the beginning. We kept that plan in mind throughout the process. We reflected and evaluated the plan and revised it when we needed to.

The process of the dissertation study is, in fact, transformational. Fullan (2011), in the *Six Secrets of Change*, discusses change leadership using the context of culture. Three of his principles came alive in the dissertation process: connect peers with purpose, capacity building, and learning is the work. Many aspects of the doctoral program align closely with these points of transformation. Although the program did not assign us to groups, the opportunity to connect with colleagues around a topic that may be important to the District seemed purposeful, and I believe will positively impact the District beyond this doctoral program. Also, the idea that "learning is the work" should be a guiding principle for all employees in an educational institution. This doctoral program has reminded me of the importance of this idea. Furthermore, the District has engaged in "capacity building" by including me and others in the grant-funded opportunity to pursue this doctoral program. I feel privileged, and, concurrently, I recognize that I have a responsibility to pay it forward by supporting others on their professional journeys.

I believe that I have always been an autonomous critical thinker, but the dissertation process has given me many opportunities to identify patterns and make sense and meaning of the data we collected. It has strengthened my ability immensely. Interestingly, as a dissertation group, we considered seeking assistance with conducting our statistical analyses, but we decided to conduct the analyses ourselves, and that, too, strengthened our practices. It was challenging, yet rewarding, to sift through thousands of data points as we prepared our files. There is a phase I frequently use, “everyone needs a thought partner,” and I used this often as the group met and verified the accuracy of data files. We quickly analyzed the data for the first question and then the data organization and analysis for research question two took approximately six weeks. It was the most challenging part of the data analysis phase. However, it was also a great learning experience. Our experience reminded me of Fullan’s (2011) idea that the way to change systems is to foster the development of practitioners.

This program of study greatly enhanced my leadership skills as an educator. As a transformational leader, I identified closely with the five practices delineated by Kouzes and Posner (1987, 2002): model the way, inspire a shared vision, challenge the process, enable others to act, and encourage the heart. As an administrator at the district level, I follow a situational approach style, which includes both directive behaviors and supportive behaviors (Northouse, 2016). I also constantly consider the ideas of Peters and Waterman (2006), who stated that excellent companies keep it simple. They focus on the basics. They provide high-quality service, prioritize, treat customers well, listen to their employees, and give them opportunities to fail forward. They also allow chaos when it leads to progress. I want to follow this model. School systems should be learning organizations, places of innovation. At the same time, they should provide superior service that leads to outstanding outcomes.

Collaborative scholarship. I could not have asked for a better group to work with throughout the dissertation journey. Our group knew each other but had not all worked closely together in the past. However, we meshed well from the initial discussions on possible problems of study. When the dissertation process started, there were four members in our group, and we all had experience with and interest in magnet programs. We worked collectively to refine our topic, but it was never difficult. My first challenge was when we were in the pre-prospectus mode, developing our research plan and decided to conduct an explanatory mixed-methods study. The last morning before our individual research began, we met with our dissertation chair and changed our research plan to a cross-case analysis. We did not have more time to work through what that meant as a group, so when each of us successfully completed our individual prospectus, we regrouped. Ultimately, with support from our dissertation chairpersons, we returned to an explanatory mixed-method approach, but in between we struggled because we were never committed to the cross-case analysis methodology.

Just after the prospectus phase, our group gained a fifth team member. He quickly meshed with the group, and it was as if he had always been a member. One of the strengths of our group was the ease with which we collaborated. We challenged each other's thinking, but in a respectful, collegial way. We quickly learned the strengths of each team member and capitalized on those strengths. I often joked that it would be great if we videotaped some of our sessions and submitted them. The discussions were rich; they were meaningful; they were honest. We laughed, and even cried, together and celebrated many shared experiences. The group process may take a little longer than individual dissertation study, but I believe the lessons of working together were worth it. The experience was powerful and strengthened us individually and collectively.

One challenge was not in the way we worked, but rather the amount of work we had to address each time we met. The group met at least one weeknight and Saturdays each week, typically from four to six hours. Additionally, we continuously communicated via email, text, and zoom conferencing. One team member provided an ongoing task list to keep our collective focus on weekly priorities. Sometimes the priorities shifted, but the task list was a valuable tool for staying on track. As the process continued, we moved from individuals in the cohort to a research team. It was a smooth transition since we had worked in similar groups throughout our course work. Complex projects require a strong emphasis on both tasks and interpersonal relationships. The group process led to a high level of accountability. Knowing that my participation affected not just my personal success, but the success of the group guided me throughout the process.

This level of research teamwork promotes a high degree of participation and will continue to do so in our organization. As a professional dedicated to M-DCPS for more than three decades, I know that employees need to be involved and committed to their work (Northouse, 2016). If we want everyone in an organization to embrace and work towards common goals, there must be a clear common understanding of the values and vision. I believe that working together has helped us develop a shared understanding, and that programs such as the William & Mary Executive Educational Doctorate program can facilitate a continued commitment to excellence.

Guillermo A. Muñoz

Leadership transformation. The experience of working on a doctoral dissertation created new habits of mind for me. I have routinely adopted an inquiry process to attempt to get at the root of issues by using the 5 Why's Process for problem identification in professional practice (Mertler, 2017). In the action research course, I had immediate take-aways. The phrase "relation does not necessarily imply causation" made an indelible impact on the manner with which I now approach problems of practice. This phrase is now at the root of inquiries that come up in my everyday practice. As educators, we assume that the initial cause of a given problem is what drives the outcome. I learned that the root causes of issues range far beyond the relationship that may be superficially evident in a given scenario. I routinely engage in personal inquiry on matters that I would have otherwise explored on the surface by seeking out prior research that may help explain a given situation or shed light on solutions to current issues.

Wilson (2004) refers to introspection "as a flashlight that illuminates thoughts and feelings that were not previously the object of a person's conscious attention" (p. 160). By shining a light on our behaviors, we can make the necessary adjustments to align how we perceive ourselves and how others perceive us. I feel this was a valuable learning process as it would be impossible to conduct a research study or investigate a problem of practice without reflecting on our professional practice.

The program developed my critical thinking skills with the vast amount of literature reviewed on relevant topics in education. Taking part in this doctoral program allowed me to develop into an avid reader and learner, gather and sift through research, and use research findings for practical application in the field. These practical applications have led me to develop, plan, and implement solutions to problems of practice in my school setting. Most recently, our school was next to last in our school district's graduation rate calculations. As a result of gathering and applying useful research, we were able to improve our graduation rate from 69% to the current graduation rate of 85%. The study detailed the importance of applying a system of early warning indicators to identify and address the students of greatest need. In the development of the plan, the strategy was to identify students and implement a tiered system of support to receive necessary interventions. I was able to address this area of concern at my school and develop practical solutions because of what I learned in this program. This program has taught me to think critically about the issues and to use research to arrive at possible solutions.

Refining my critical thinking process expanded my frame of reference and allowed me to evolve as a leader. The experience of implementing this process in my professional work has impacted my leadership style. As a result of this capacity building, armed with the research that guided our actions, it allowed me to guide the process to increase our school's graduation rate and improve the perception of the school in the public's mind. The rigorous academic concepts learned through this experience strengthened my transformational leadership skills. The experience of this program provided me with the ability to identify the type of leadership required in different situations based on reality (Wheatley, 2006).

Collaborative scholarship. There are challenges and rewards in completing a doctoral dissertation as a group. Although ongoing group collaboration presents many challenges, it is also gratifying because of the high level of thought exchange. The level of professional conversation demands that all members be well versed in theory, as well as research to be a productive contributor.

Identifying a problem of practice was perhaps the most challenging part of the dissertation study. Initially, I was collaborating with a colleague on a different problem of practice, but I was given the opportunity to join another group in the pre-proposal stage. The group I joined was studying the impact of STEM magnet programs on student achievement and was composed of high school principals, region personnel, and district personnel. I assimilated with the group from the onset and delved into the research immediately. I was truly fortunate to have been placed with my colleagues. While I was hesitant to contribute at first, it was only a matter of days before they made me feel like a full member of the group. Initially, I would withhold my opinion on individual decisions due to the timing of my integration into the dissertation group. However, after expressing my opinion on a couple of instances, and seeing how my view was given the same consideration as those of other team members, I felt free to become a full participant in the process moving forward. I am grateful for the opportunity to have collaborated with such a group of dedicated professionals.

One of the advantages before engaging in the dissertation work as a group was the opportunity the program provided us to work together on group assignments during the first year and a half. During the program, each of us was able to work with all members of the cohort at different times. These opportunities provided us the necessary experiences to build strong relationships that would serve us well during our dissertation study. The ability to work collectively to conduct the research was organic because of these early experiences. We were able to learn about our strengths and weaknesses and gain knowledge from each other.

There were some challenges during the dissertation process. However, we were able to overcome these challenges because of having had the opportunity to communicate with one another throughout the program. Clear and transparent communication lent to clinical feedback rather than personal opinions of others' thoughts or ideas. There was a high level of commitment and expectation that each of our contributions would be of the highest quality for the benefit of the group. The strong communication and commitment demonstrated by members of the team turned these challenges into advantages of working as a group rather than as an individual during a dissertation.

When we began the program, each of us had an opportunity to absorb the material from our perspectives. Initially working in groups in different courses provided opportunities to complete discussion board posts, each of us brought a different perspective to the same issue, enhancing the learning process. The transition of going from an individual member in the cohort to a member of a research team resembled the experiences we were afforded when we were provided group assignments in the academic courses.

There were many lessons learned during this process of working as a team. One of the most important lessons learned was to stay current with assignments and deadlines.

Group accountability provided the understanding that the journey forward also involved others, making the experience and journey far more valuable and more significant than yourself. One recommendation I would make is to provide the members of future cohorts with additional opportunities to visit the campus and engage with students on campus. While we were able to visit one time, a second visit would have afforded members of the cohort with an additional opportunity to collaborate with other members of the Tribe faculty. The additional opportunity to gather and exchange ideas face to face with the faculty about our dissertation would have served to enhance upon the many Zoom sessions we participated in. The ability to see our professors' body language and facial expressions in person would have further contributed to the collegiality we built over time during our online discussions. Nevertheless, the courses and timeline of this doctoral program from beginning to end were very well planned out and provided the participants with a rich and rigorous program of study.

Appendix A

M-DCPS Graduation Withdrawal Codes

Code	Definition	Grad. Impact
DNE	Student who was expected to attend a school but did not enter as expected for unknown reasons	🟥
W01	Student promoted, retained, or transferred to another attendance reporting unit in the same school	🟥
*W02	Student promoted, retained, or transferred to another school in the same district	🟥
**W3A	Student who withdraws to attend a public school in another district	🟨
W3B	Student who withdraws to attend another public school out-of-state	🟨
W04	Student who withdraws to attend a nonpublic school in- or out-of-state	🟨
W05	Student age 16 or older who leaves school voluntarily with no intention of returning	🟥
W06	Student who graduated and met all requirements to receive a standard diploma	🟩
W6A	Student who graduated and met all requirements to receive a standard diploma on the 18-credit college preparatory graduation option	🟩
W6B	Student who graduated and met all requirements to receive a standard diploma on the 18-credit career preparatory graduation option	🟩
W07	Student who graduated from school with a special diploma based on option one	🟥
W08	Student who received a certificate of completion	🟥
W8A	Student who met all requirements. to receive a standard diploma except for an FCAT/FCAT concordant score	🟥
W8B	Student who received a certificate of completion. The student met the minimum credits but did not pass the state approved graduation test or an alternate assessment, and/or did not achieve the required GPA. (Certificate of Completion, 18-Credit Option)	🟥
W8C	Student who met all of the requirements to receive a standard diploma (18-credit option) except passing the State approved graduation test and received a certificate of completion and is eligible to take the Postsecondary Education Readiness Test (P.E.R.T.) and be admitted to remedial or credit courses at a state community college as appropriate.	🟥
W09	Student who received a special certificate of completion	🟥
W10	Student in a GED Exit Option Model who passed the GED Tests and the graduation test and was awarded a standard diploma	🟥
W12	Student deceased	🟨
W13	Student withdrawn due to court action	🟥
W15	Student withdrawn due to nonattendance	🟥
W18	Student withdrawn due to medical reasons	🟥
W21	Student expelled	🟥
W22	Student whereabout unknown	🟥
W23	Student withdrawn for any reason other than W01-W22 or W24-W27	🟥
W24*	Student withdrawn to attend a Home Education program	🟥
W25	Student under the age of 6 who withdraws from school	
W26	Student who withdraws to attend an adult education program prior to completing graduation requirements	🟥
W27	Student who graduated from school with a special diploma based on option two – mastery of employment and community competencies	🟥
W43	An adult student that graduated from school with a standard diploma	🟩
W44	Student who left school with a certificate of completion	🟥
W45	An adult student who left school with a State of Florida diploma (GED)	🟥
W52	Student who graduated from school with a standard diploma and satisfied the graduation test requirement through an alternate assessment	🟩

WFW	Student who graduated with a standard diploma and an FCAT waiver	🟩
WFT	Student who graduated with a standard diploma and satisfied the graduation test requirement through an alternate assessment (For students meeting accelerated high school graduation option requirements, see WFA and WFB)	🟩
WFA	Student who graduated from school with a standard diploma based on an 18-credit college preparatory graduation option and satisfied the graduation test requirement through an alternate assessment	🟩
WFB	Student who graduated from school with a standard diploma based on an 18-credit career preparatory graduation option and satisfied the graduation test requirement through an alternate assessment	🟩
WGA	Student in a GED Exit Option Model who passed the GED Tests, satisfied the graduation test requirement through an alternate assessment, and was awarded a standard diploma.	🟥
WGD	Student in a GED Exit Option Model who passes the GED Tests but did not pass the graduation test and was awarded a State of Florida diploma	🟥
WPO	Student withdrawn from school subsequent to receiving a W07, W08, W09, or W27 during the student’s year of high school completion. (Example: ESE student who opts to remain in school for an additional year.)	
WXL	Student who graduated from school and met all of the requirements to receive a standard diploma based on the Academically Challenging Curriculum to Enhance Learning (AACCEL) options, s. 1002.3105(3), F.S.	🟩
WXT	Any student who graduated from school and met all of the requirements to receive a standard diploma based on the Academically Challenging Curriculum to enhance Learning (AACCEL) options, s. 1002.3105(3), F.S., and satisfied the state graduation test requirement through an approved state alternate assessment score	🟩
WXW	Any student with disabilities who graduated from school and met all of the requirements to receive a standard diploma based on the Academically Challenging Curriculum to Enhance Learning (AACCEL) options, s. 1002.3105(3), F.S., and satisfied the state graduation test requirement with an approved statewide assessment waiver	🟩
WRW	Student with disabilities who graduated from school with a standard diploma and a Statewide Standardized Assessment Results Waiver.	🟩
W54	Adult standard high school diploma (ACCELL) 18-crdit option	🟩
W55	Adult standard high school diploma (ACCELL), alternate assessment score, 18-credit option	🟩
WD1	Student with disabilities who met all of the requirements to receive a standard diploma who deferred receipt of the diploma to remain eligible for FAPE, per section 1003.4282(11)(c), F.S.	🟩

Appendix B

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS TEACHER EFFICACY AND ATTITUDES SURVEY (T-STEM)

(used with permission from the Friday Institute for Educational Innovation)

Directions:
For each of the following statements, please indicate the degree to which you agree or disagree. Even though some statements are very similar, please answer each statement. There are no “right’ or “wrong” answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.

STEM Teaching Efficacy and Beliefs

Please respond to these questions regarding your feelings and about your own teaching.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am continually improving my STEM teaching practice.					
I know the steps necessary to teach STEM effectively.					
I am confident that I can explain to students why STEM experiments work.					
I am confident that I can teach STEM effectively.					
I wonder if I have the necessary skills to teach STEM.					
I understand STEM concepts well enough to be effective in teaching.					
Given a choice, I would invite a colleague to evaluate my STEM teaching.					
I am confident that I can answer students’ STEM questions.					
When a student has difficulty understanding a STEM concept, I am confident that I know how to help the student understand it better.					

STEM Teaching Efficacy and Beliefs (Continued)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
When teaching STEM, I am confident enough to welcome student questions.					
I know what to do to increase student interest in STEM.					

STEM Teaching Outcome Expectancy

The following questions ask about your feelings about teaching in general. Please respond accordingly.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
When a student does better than usual in STEM, it is often because the teacher exerts a little extra effort.					
The inadequacy of a student's STEM background can be overcome by good teaching.					
When a student's learning in STEM is greater than expected, it is most often due to their teacher having found a more effective teaching approach.					
The teacher is generally responsible for students' learning in STEM.					
If students' learning in STEM is less than expected, it is most likely due to ineffective STEM teaching.					
Students' learning in STEM is directly related to their teacher's effective STEM teaching.					
When a low achieving child progresses more than expected in STEM, it is usually due to extra attention given by the teacher.					

STEM Teaching Outcome Expectancy (Continued)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
If parents comment that their child is showing more interest in STEM at school, it is probably due to the performance of the child's teacher.					
Minimal student learning in STEM can generally be attributed to their teachers.					

STEM Instruction

Please answer the following questions about how often students engage in the following tasks during your instruction time.

"During STEM instruction meetings (e.g. class periods, after school activities, etc.), how often do your students…"

	Never	Occasionally	About Half the Time	Usually	Every Time
Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations).					
Work in small groups.					
Make predictions that can be tested.					
Make careful observations or measurements.					
Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.).					
Recognize patterns in data.					
Create reasonable explanations of results of an experiment or investigation.					
Choose the most appropriate methods to express results (e.g. drawings, models, charts, graphs, technical language, etc.).					
Complete activities with real-world context.					

STEM Instruction (continued)	Never	Occasionally	About Half the Time	Usually	Every Time
Engage in content-driven dialogue.					
Reason abstractly.					
Reason quantitatively.					
Critique the reasoning of others.					
Learn about careers related to the instructional content.					

Demographic Information:

1. What subject do you teach?
2. How many years have you been teaching?
3. Are you teaching within the STEM magnet program at your school?
4. How many years have you taught within the STEM magnet program at your school?
5. How many STEM magnet periods do you teach?
6. How many non-STEM magnet periods do you teach?
7. What is your highest level of education?
   - ○ Bachelor’s Degree
   - ○ Master’s Degree
   - ○ Specialist’s Degree
   - ○ Doctoral Degree
8. In your opinion, what factors inhibit a student’s successful completion of a STEM magnet program?
9. In your opinion, what factors contribute to a student’s successful completion of a STEM magnet program?
10. In your opinion, what skills does a teacher need to teach successfully within the STEM magnet program?
11. Please share any other comments you may have about the STEM magnet program in your school.

Appendix C

Science, Technology, Engineering, And Mathematics Principal Leadership Survey (P-STEM)

(used with permission from the Friday Institute for Educational Innovation)

Please answer these survey questions honestly and to the best of your ability. The information collected will be kept confidential and used for research purposes only.

Please indicate your level of agreement with the following statements.

At my school, I…	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Have articulated a vision					
Model inquiry-based learning					
Encourage a culture of innovation among teachers and students					
Make sure teachers have access to resources for STEM teaching and learning (e.g., lab facilities, project supplies, lab equipment, project rooms, etc.)					
Ensure technical support is available for instructional technology needs					
Make sure teachers have access to instructional technology tools that facilitate their work (e.g., laptops, digital projectors, software, virtual applications, learning management systems, etc.)					
Ensure technical support is available for lab equipment and/or other resources for STEM teaching					
Share research and best practices with teachers.					
Support teachers to implement project-based learning.					
Understand that incorporating inquiry-based teaching may take more time for teachers					
Include teachers in decision-making					
Include teachers in decisions about measuring student success in STEM.					
Request feedback from teachers on the progress of the STEM program.					
Set ambitious, yet realistic (i.e., not too high, and not too low) goals.					

At my school, I…	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Advocate for policies that support STEM education at the district level.					
Support teachers using a variety of indicators of student success (e.g. performance-based, project-based, portfolios, etc.).					
Use multiple sources of data for evaluating the impact on students.					
Provide constructive feedback to teachers.					
Implement practices to increase participation of students from underrepresented groups in STEM.					
Maintain strategic partnerships with STEM industries					
Set clear expectations for teachers.					
Provide space for students to collaborate, work on projects, hold exhibitions, etc.					
Enable collaboration of teachers across content areas.					
Provide consistent professional development specific to the STEM program.					
Set clear expectations for students.					
Use an action plan to implement STEM education.					
Provide opportunities for teacher to have applied STEM learning experiences (e.g. industry tours, study trips, job shadowing).					
Support the formal, in-school provision of authentic learning experiences connected to current STEM research or industry for students.					
Communicate to the larger community about the STEM program.					
Support the informal, extracurricular provision of authentic learning experiences connected to current STEM research or industry for students.					
I feel prepared to lead the STEM program					
I feel confident in leading a STEM program.					
I feel knowledgeable about the characteristics of STEM teaching.					
I feel knowledgeable about the characteristics of STEM learning.					

1. Your position in the school is:
    - ○ Principal
    - ○ Assistant Principal
2. How many years of experience do you have in your current role?
3. How many total years of experience do you have in school administration?
4. In your opinion, what factors inhibit a student's successful completion of a STEM magnet program?
5. In your opinion, what factors contribute to a student's successful completion of a STEM magnet program?
6. In your opinion, what skills does a teacher need to teach successfully within the STEM magnet program?
7. Please share any other comments you may have about the STEM magnet program in your school.

Appendix D

T-STEM Survey Permission (Science Teacher)

Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey

Science Teacher

Last updated December 2012

Appropriate Use
The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness. The survey is available to help program coordinators make decisions about possible improvements to their program.

The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will maintain the confidentiality of all data.

Recommended citation for this survey:
Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Science Teachers,* Raleigh, NC: Author.

The development of this survey was partially supported by the National Science Foundation under Grant No. 1038154 and by The Golden LEAF Foundation.

The framework for part of this survey was developed from the following sources:
Riggs, I.M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637. doi: 10.1002/sce.3730740605

Appendix E

T-STEM Survey Permission (Technology Teacher)

Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey

Technology Teacher

Last updated December 2012

Appropriate Use
The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness. The survey is available to help program coordinators make decisions about possible improvements to their program.

The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will take appropriate measures to maintain the confidentiality of all data.

Recommended citation for this survey:
Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Technology Teachers,* Raleigh, NC: Author.

The development of this survey was partially supported by the National Science Foundation under Grant No. 1038154 and by The Golden LEAF Foundation.

The framework for part of this survey was developed from the following sources:
Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637. doi: 10.1002/sce.3730740605

Appendix F

T-STEM Survey Permission (Engineering Teacher)

Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey

Engineering Teacher

Last updated December 2012

Appropriate Use

The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness. The survey is available to help program coordinators make decisions about possible improvements to their program.

The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will take appropriate measures to maintain the confidentiality of all data.

Recommended citation for this survey:

Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Engineering Teachers*, Raleigh, NC: Author.

The development of this survey was partially supported by the National Science Foundation under Grant No. 1038154 and by The Golden LEAF Foundation.

The framework for part of this survey was developed from the following sources:
Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637. doi: 10.1002/sce.3730740605

Appendix G

T-STEM Survey Permission (Mathematics Teacher)

This project received support from The Golden LEAF Foundation.

Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey

Mathematics Teacher

Last updated December 2012

Appropriate Use
The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness. The survey is available to help program coordinators make decisions about possible improvements to their program.

The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will take appropriate measures to maintain the confidentiality of all data.

Recommended citation for this survey:
Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Mathematics Teachers,* Raleigh, NC: Author.

The development of this survey was partially supported by the National Science Foundation under Grant No. 1038154 and by The Golden LEAF Foundation.

The framework for part of this survey was developed from the following sources:
Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637. doi: 10.1002/sce.3730740605

Appendix H

P-STEM Survey Permission (Principals)

Pilot Leadership for STEM Self-Assessment

Last updated December 2012

Appropriate Use
The Pilot Leadership for STEM Self-Assessment is intended to measure changes in principals' self-assessed leadership for STEM education. More specifically, the survey measures the principals' leadership for STEM in promoting and supporting: vision, infrastructure, professional development, shared decision making, advocacy, and evaluation. The survey is available to help principals and program coordinators make decisions about possible improvements to their STEM education work.

The Friday Institute grants you permission to use these instruments for educational, non-commercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will maintain the confidentiality of all data.

Recommended citation for this survey:
Friday Institute for Educational Innovation (2012). *Pilot Leadership for STEM Self-Assessment,* Raleigh, NC: Author.

The development of this survey was partially supported by the National Science Foundation under Grant No. 1038154 and by The Golden LEAF Foundation.

The framework for part of this survey was developed from the following sources:
Friday Institute for Educational Innovation (2010). *Leadership Framework for Technology Innovations in Schools,* Raleigh, NC: Author.

Appendix I

T-STEM Survey Results of Personal Teaching Efficacy and Beliefs (PTEBS).

Question Number	Question	Teacher Type	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
TEB1	I am continually improving my STEM teaching practice.	Magnet (21)	52.4% (11)	38.1% (8)	0%	0%	9.5% (2)
		Non-Magnet (49)	24.5% (12)	38.8% (19)	28.6% (14)	2.0% (1)	6.1% (3)
TEB2	I know the steps necessary to teach STEM effectively.	Magnet (21)	19.0% (4)	61.9% (13)	14.3% (3)	0%	4.8% (1)
		Non-Magnet (49)	24.5% (12)	30.6% (15)	28.6% (14)	6.1% (3)	10.2% (5)
TEB3	I am confident that I can explain to students why STEM experiments work.	Magnet (21)	42.9% (9)	47.6% (10)	4.8% (1)	4.8% (1)	0%
		Non-Magnet (49)	30.6% (15)	32.7% (16)	20.4% (10)	6.1% (3)	10.2% (5)
TEB4	I am confident that I can teach STEM effectively.	Magnet (21)	28.6% (6)	66.7% (14)	4.8% (1)	0%	0%
		Non-Magnet (49)	36.7% (18)	4.1% (2)	30.6% (15)	22.4% (11)	6.1% (3)
TEB5	I wonder if I have the necessary skills to teach STEM.	Magnet (21)	4.8% (1)	9.5% (2)	14.3% (3)	47.6% (10)	23.8% (5)
		Non-Magnet (49)	2.0% (1)	28.6% (14)	34.7% (17)	14.3% (7)	20.4% (10)
TEB6	I understand STEM concepts well enough to be effective in teaching.	Magnet (21)	23.8% (5)	76.2% (16)	0%	0%	0%
		Non-Magnet (49)	30.6% (15)	34.7% (17)	20.4% (10)	6.1% (3)	8.2% (4)
TEB7	Given a choice, I would invite a colleague to evaluate my STEM teaching.	Magnet (21)	23.8% (5)	57.1% (12)	4.8% (1)	14.3% (7)	0%
		Non-Magnet (49)	12.2% (6)	38.8% (19)	32.7% (16)	8.2% (4)	8.2% (4)
TEB8	I am confident that I can answer students' STEM questions.	Magnet (21)	33.3% (7)	57.1% (12)	9.5% (2)	0%	0%
		Non-Magnet (49)	20.4% (10)	44.9% (22)	20.4% (10)	10.2% (5)	4.1% (2)
TEB9	When a student has difficulty understanding a STEM concept, I am confident that I know how to help the student understand it better.	Magnet (21)	28.6% (6)	61.9% (13)	9.5% (2)	0%	0%
		Non-Magnet (49)	16.3% (8)	49.0% (24)	24.5% (12)	6.1% (3)	4.1% (2)
TEB10	When teaching STEM, I am confident enough to welcome student questions.	Magnet (21)	57.1% (12)	38.1% (8)	4.8% (1)	0%	0%
		Non-Magnet (48)	36.7% (18)	36.7% (18)	20.4% (10)	4.1% (2)	0%
TEB11	I know what to do to increase student interest in STEM.	Magnet (21)	19.0% (4)	52.4% (11)	23.8% (5)	4.8% (1)	0%
		Non-Magnet (48)	22.4% (11)	34.7% (17)	32.7% (16)	8.2% (4)	0%

Note. 20 magnet and 48 non-magnet teachers completed the entire T-STEM Survey; however, 21 magnet and 48 non-magnet teachers completed this portion of the survey.

Appendix J

T-STEM Survey Results of Teacher Outcome Expectancy (TOES)

Question Number	Question	Teacher Type	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly disagree
TOE1	When a student does better than usual in STEM, it is often because the teacher exerts a little extra effort.	Magnet (21)	23.8% (5)	38.1% (8)	33.3% (7)	4.8% (1)	0%
		Non-Magnet (48)	6.1% (3)	46.9% (23)	40.8% (20)	4.1% (2)	0%
TOE2	The inadequacy of a student's STEM background can be overcome by good teaching.	Magnet (21)	9.5% (2)	57.1% (12)	23.8% (5)	4.8% (1)	4.8% (1)
		Non-Magnet (48)	20.4% (9)	44.9% (22)	26.5% (13)	6.1% (3)	0%
TOE3	When a student's learning in STEM is greater than expected, it is most often due to their teacher having found a more effective teaching approach.	Magnet (21)	9.5% (2)	47.6% (10)	38.1% (8)	0%	4.8% (1)
		Non-Magnet (49)	8.2% (4)	42.9% (21)	42.9% (21)	4.1% (2)	0%
TOE4	The teacher is generally responsible for students' learning in STEM.	Magnet (21)	9.5% (2)	33.3% (7)	42.9% (9)	4.8% (1)	9.5% (2)
		Non-Magnet (48)	2.0% (1)	46.9% (23)	30.6% (15)	18.4% (9)	0%
TOE5	If students' learning in STEM is less than expected, it is most likely due to ineffective STEM teaching.	Magnet (21)	0%	28.6% (6)	42.9% (9)	23.8% (5)	4.8% (1)
		Non-Magnet (48)	4.1% (2)	20.4% (10)	46.9% (23)	24.5% (12)	2.0% (1)
TOE6	Students' learning in STEM is directly related to their teacher's effective STEM teaching.	Magnet (21)	0%	38.1% (8)	52.4% (11)	9.5% (2)	0%
		Non-Magnet (48)	4.1% (2)	36.7% (18)	49.0% (24)	8.2% (4)	0%
TOE7	When a low achieving child progresses more than expected in STEM, it is usually due to extra attention given by the teacher.	Magnet (21)	14.3% (3)	38.1% (8)	38.1% (8)	9.5% (2)	0%
		Non-Magnet (48)	2.0% (1)	51.0% (25)	38.8% (19)	6.1% (3)	0%

Question Number	Question	Teacher Type	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly disagree
TOE8	If parents comment that their child is showing more interest in STEM at school, it is probably due to the performance of the child's teacher.	Magnet (21)	14.3% (3)	52.4% (11)	23.8% (5)	9.5% (2)	0%
		Non-Magnet (48)	6.1% (3)	34.7% (17)	51.0% (25)	6.1% (3)	0%
TOE9	Minimal student learning in STEM can generally be attributed to their teachers.	Magnet (21)	0%	47.6% (10)	28.6% (6)	23.8% (5)	0%
		Non-Magnet (48)	4.1% (2)	16.3% (8)	59.2% (29)	18.4% (9)	0%

Note. 20 magnet and 48 non-magnet teachers completed the entire T-STEM Survey however, 21 magnet and 48 non-magnet teachers completed this portion of the survey.

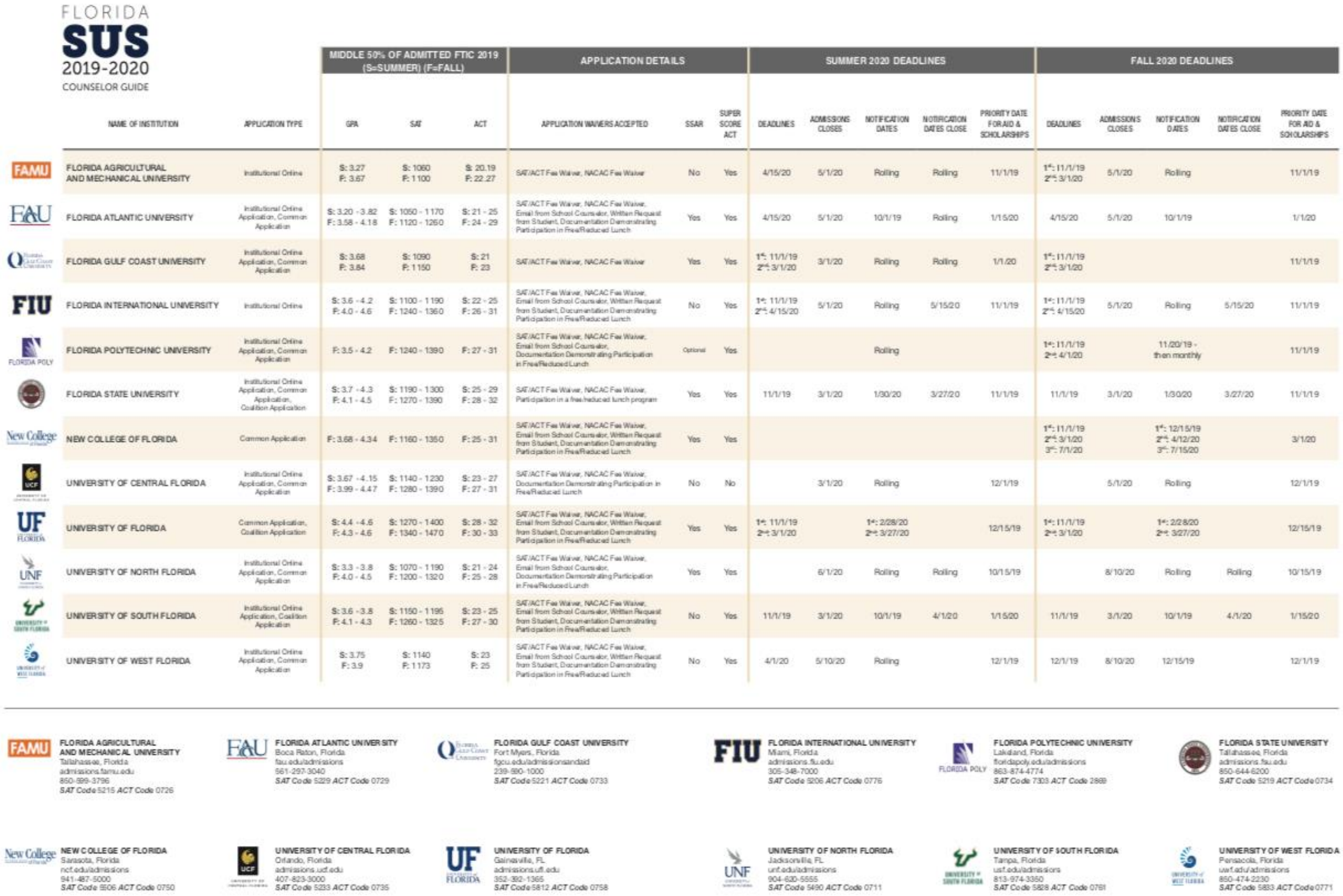
Appendix K

T-STEM Survey Results of STEM Instruction (SI)

Question Number	Question	Teacher Type	Never	Occasionally	About Half the Time	Usually	Every Time
SI1	Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations).	Magnet (20)	4.8% (1)	19.0% (4)	14.3% (3)	23.8% (5)	33.3% (7)
		Non-Magnet (48)	2.0% (1)	24.5% (12)	16.3% (8)	36.7% (18)	18.4% (9)
SI2	Work in small groups.	Magnet (20)	0%	4.8% (1)	14.3% (3)	38.1% (8)	38.1% (8)
		Non-Magnet (48)	0.00%	18.4% (9)	24.5% (12)	40.8% (20)	14.3% (7)
SI3	Make predictions that can be tested.	Magnet (20)	4.8% (1)	14.3% (3)	14.3% (3)	38.1% (8)	23.8% (5)
		Non-Magnet (48)	8.2% (4)	20.4% (10)	12.2% (6)	44.9% (22)	12.2% (6)
SI4	Make careful observations or measurements.	Magnet (20)	9.5% (2)	9.5% (2)	4.8% (1)	28.6% (6)	42.9% (9)
		Non-Magnet (48)	8.2% (4)	10.2% (5)	12.2% (6)	49.0% (24)	18.4% (9)
SI5	Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.).	Magnet (20)	0%	19.0% (4)	0%	38.1% (8)	38.1% (8)
		Non-Magnet (48)	2.0% (1)	16.3% (8)	12.2% (6)	36.7% (18)	30.6% (15)
SI6	Recognize patterns in data.	Magnet (20)	4.8% (1)	9.5% (2)	9.5% (2)	38.1% (8)	33.3% (7)
		Non-Magnet (48)	0%	12.2% (6)	8.2% (4)	57.1% (28)	20.4% (10)
SI7	Create reasonable explanations of results of an experiment or investigation.	Magnet (20)	4.8% (1)	9.5% (2)	9.5% (2)	38.1% (8)	33.3% (7)
		Non-Magnet (48)	6.1% (3)	12.2% (6)	8.2% (4)	51.0% (25)	20.4% (10)

Question Number	Question	Teacher Type	Never	Occasionally	About Half the Time	Usually	Every Time
SI8	Choose the most appropriate methods to express results (e.g. drawings, models, charts, graphs, technical language, etc.).	Magnet (20)	4.8% (1)	9.5% (2)	9.5% (2)	33.3% (7)	38.1% (8)
		Non-Magnet (48)	0%	14.3% (7)	10.2% (5)	51.0% (25)	22.4% (11)
SI9	Complete activities with real-world context.	Magnet (20)	4.8% (1)	4.8% (1)	14.3% (3)	23.8% (5)	47.6% (10)
		Non-Magnet (48)	0%	8.2% (4)	16.3% (8)	51.0% (25)	22.4% (11)
SI10	Engage in content-driven dialogue.	Magnet (20)	0%	0%	4.8% (1)	52.4% (11)	38.1% (8)
		Non-Magnet (48)	0%	10.2% (5)	10.2% (5)	46.9% (23)	30.6% (15)
SI11	Reason abstractly.	Magnet (20)	0%	19.0% (4)	19.0% (4)	42.9% (9)	14.3% (7)
		Non-Magnet (48)	0%	14.3% (7)	18.4% (9)	46.9% (23)	18.4% (9)
SI12	Reason quantitatively.	Magnet (20)	0%	14.3% (3)	14.3% (3)	47.6% (10)	19.0% (4)
		Non-Magnet (48)	2.0% (1)	6.1% (3)	18.4% (9)	42.9% (21)	28.6% (14)
SI13	Critique the reasoning of others.	Magnet (20)	4.8% (1)	28.6% (6)	4.8% (1)	47.6% (10)	9.5% (2)
		Non-Magnet (48)	4.1% (2)	30.6% (15)	16.3% (8)	34.7% (17)	12.2% (6)
SI14	Learn about careers related to the instructional content.	Magnet (20)	9.5% (2)	14.3% (3)	0%	52.4% (11)	19.0% (4)
		Non-Magnet (48)	4.1% (2)	32.7% (16)	6.1% (3)	36.7% (18)	18.4% (9)

Appendix L
Florida SUS 2019-2020 Counselor Guide



FLORIDA
SUS
2019-2020
COUNSELOR GUIDE

NAME OF INSTITUTION	APPLICATION TYPE	MIDDLE 50% OF ADMITTED FTIC 2019 (S=SUMMER) (F=FALL)			APPLICATION DETAILS			SUMMER 2020 DEADLINES					FALL 2020 DEADLINES				
		GPA	SAT	ACT	APPLICATION WAIVERS ACCEPTED	SSAR	SUPER SCORE ACT	DEADLINES	ADMISSIONS CLOSES	NOTIFICATION DATES	NOTIFICATION DATES CLOSE	PRIORITY DATE FOR AID & SCHOLARSHIPS	DEADLINES	ADMISSIONS CLOSES	NOTIFICATION DATES	NOTIFICATION DATES CLOSE	PRIORITY DATE FOR AID & SCHOLARSHIPS
FLORIDA AGRICULTURAL AND MECHANICAL UNIVERSITY	Institutional Online	S: 3.27 F: 3.67	S: 1060 F: 1100	S: 20.19 F: 22.27	SAT/ACT Fee Waiver, NACAC Fee Waiver	No	Yes	4/15/20	5/1/20	Rolling	Rolling	11/1/19	1st: 11/1/19 2nd: 3/1/20	5/1/20	Rolling		11/1/19
FLORIDA ATLANTIC UNIVERSITY	Institutional Online Application, Common Application	S: 3.20 - 3.82 F: 3.58 - 4.18	S: 1050 - 1170 F: 1120 - 1260	S: 21 - 25 F: 24 - 29	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Written Request from Student, Documentation Demonstrating Participation in Free/Reduced Lunch	Yes	Yes	4/15/20	5/1/20	10/1/19	Rolling	1/15/20	4/15/20	5/1/20	10/1/19		1/1/20
FLORIDA GULF COAST UNIVERSITY	Institutional Online Application, Common Application	S: 3.68 F: 3.84	S: 1090 F: 1150	S: 21 F: 23	SAT/ACT Fee Waiver, NACAC Fee Waiver	Yes	Yes	1st: 11/1/19 2nd: 3/1/20	3/1/20	Rolling	Rolling	1/1/20	1st: 11/1/19 2nd: 3/1/20				11/1/19
FLORIDA INTERNATIONAL UNIVERSITY	Institutional Online	S: 3.6 - 4.2 F: 4.0 - 4.6	S: 1100 - 1190 F: 1240 - 1360	S: 22 - 25 F: 26 - 31	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Written Request from Student, Documentation Demonstrating Participation in Free/Reduced Lunch	No	Yes	1st: 11/1/19 2nd: 4/15/20	5/1/20	Rolling	5/15/20	11/1/19	1st: 11/1/19 2nd: 4/15/20	5/1/20	Rolling	5/15/20	11/1/19
FLORIDA POLYTECHNIC UNIVERSITY	Institutional Online Application, Common Application	F: 3.5 - 4.2	F: 1240 - 1390	F: 27 - 31	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Documentation Demonstrating Participation in Free/Reduced Lunch	Optional	Yes			Rolling			1st: 11/1/19 2nd: 4/1/20		11/20/19 - then monthly		11/1/19
FLORIDA STATE UNIVERSITY	Institutional Online Application, Common Application, Coalition Application	S: 3.7 - 4.3 F: 4.1 - 4.5	S: 1190 - 1300 F: 1270 - 1390	S: 25 - 29 F: 28 - 32	SAT/ACT Fee Waiver, NACAC Fee Waiver, Participation in a free/reduced lunch program	Yes	Yes	11/1/19	3/1/20	1/30/20	3/27/20	11/1/19	11/1/19	3/1/20	1/30/20	3/27/20	11/1/19
NEW COLLEGE OF FLORIDA	Common Application	F: 3.68 - 4.34	F: 1160 - 1350	F: 25 - 31	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Written Request from Student, Documentation Demonstrating Participation in Free/Reduced Lunch	Yes	Yes						1st: 11/1/19 2nd: 3/1/20 3rd: 7/1/20		1st: 12/15/19 2nd: 4/12/20 3rd: 7/15/20		3/1/20
UNIVERSITY OF CENTRAL FLORIDA	Institutional Online Application, Common Application	S: 3.67 - 4.15 F: 3.99 - 4.47	S: 1140 - 1230 F: 1280 - 1390	S: 23 - 27 F: 27 - 31	SAT/ACT Fee Waiver, NACAC Fee Waiver, Documentation Demonstrating Participation in Free/Reduced Lunch	No	No		3/1/20	Rolling		12/1/19		5/1/20	Rolling		12/1/19
UNIVERSITY OF FLORIDA	Common Application, Coalition Application	S: 4.4 - 4.6 F: 4.3 - 4.6	S: 1270 - 1400 F: 1340 - 1470	S: 28 - 32 F: 30 - 33	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Written Request from Student, Documentation Demonstrating Participation in Free/Reduced Lunch	Yes	Yes	1st: 11/1/19 2nd: 3/1/20		1st: 2/28/20 2nd: 3/27/20		12/15/19	1st: 11/1/19 2nd: 3/1/20		1st: 2/28/20 2nd: 3/27/20		12/15/19
UNIVERSITY OF NORTH FLORIDA	Institutional Online Application, Common Application	S: 3.3 - 3.8 F: 4.0 - 4.5	S: 1070 - 1190 F: 1200 - 1320	S: 21 - 24 F: 25 - 28	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Documentation Demonstrating Participation in Free/Reduced Lunch	Yes	Yes		6/1/20	Rolling	Rolling	10/15/19		8/10/20	Rolling	Rolling	10/15/19
UNIVERSITY OF SOUTH FLORIDA	Institutional Online Application, Coalition Application	S: 3.6 - 3.8 F: 4.1 - 4.3	S: 1150 - 1195 F: 1260 - 1325	S: 23 - 25 F: 27 - 30	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Written Request from Student, Documentation Demonstrating Participation in Free/Reduced Lunch	No	Yes	11/1/19	3/1/20	10/1/19	4/1/20	1/15/20	11/1/19	3/1/20	10/1/19	4/1/20	1/15/20
UNIVERSITY OF WEST FLORIDA	Institutional Online Application, Common Application	S: 3.75 F: 3.9	S: 1140 F: 1173	S: 23 F: 25	SAT/ACT Fee Waiver, NACAC Fee Waiver, Email from School Counselor, Written Request from Student, Documentation Demonstrating Participation in Free/Reduced Lunch	No	Yes	4/1/20	5/10/20	Rolling		12/1/19	12/1/19	8/10/20	12/15/19		12/1/19

FLORIDA AGRICULTURAL AND MECHANICAL UNIVERSITY
Tallahassee, Florida
admissions.famu.edu
850-599-3796
SAT Code 5215 ***ACT Code*** 0726

FLORIDA ATLANTIC UNIVERSITY
Boca Raton, Florida
fau.edu/admissions
561-297-3040
SAT Code 5229 ***ACT Code*** 0729

FLORIDA GULF COAST UNIVERSITY
Fort Myers, Florida
fgcu.edu/admissionsandaid
239-590-1000
SAT Code 5221 ***ACT Code*** 0733

FLORIDA INTERNATIONAL UNIVERSITY
Miami, Florida
admissions.fiu.edu
305-348-7000
SAT Code 5206 ***ACT Code*** 0776

FLORIDA POLYTECHNIC UNIVERSITY
Lakeland, Florida
floridapoly.edu/admissions
863-874-4774
SAT Code 7303 ***ACT Code*** 2869

FLORIDA STATE UNIVERSITY
Tallahassee, Florida
admissions.fsu.edu
850-644-6200
SAT Code 5219 ***ACT Code*** 0734

NEW COLLEGE OF FLORIDA
Sarasota, Florida
ncf.edu/admissions
941-487-5000
SAT Code 5506 ***ACT Code*** 0750

UNIVERSITY OF CENTRAL FLORIDA
Orlando, Florida
admissions.ucf.edu
407-823-3000
SAT Code 5233 ***ACT Code*** 0735

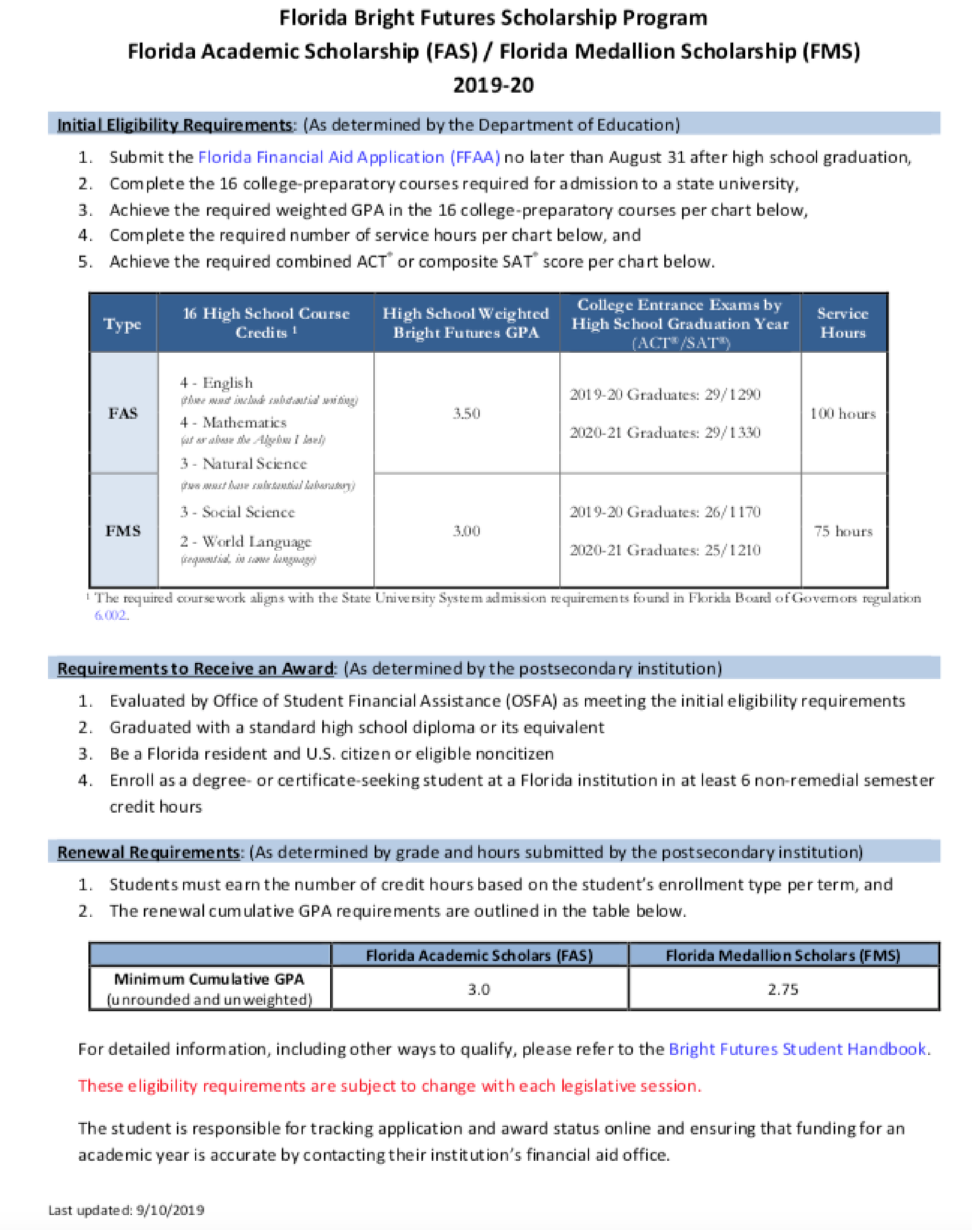
UNIVERSITY OF FLORIDA
Gainesville, FL
admissions.ufl.edu
352-392-1365
SAT Code 5812 ***ACT Code*** 0758

UNIVERSITY OF NORTH FLORIDA
Jacksonville, FL
unf.edu/admissions
904-620-5555
SAT Code 5490 ***ACT Code*** 0711

UNIVERSITY OF SOUTH FLORIDA
Tampa, Florida
usf.edu/admissions
813-974-3350
SAT Code 5828 ***ACT Code*** 0761

UNIVERSITY OF WEST FLORIDA
Pensacola, Florida
uwf.edu/admissions
850-474-2230
SAT Code 5833 ***ACT Code*** 0771

Appendix M



Florida Bright Futures Scholarship Program

Florida Academic Scholarship (FAS) / Florida Medallion Scholarship (FMS)

2019-20

Initial Eligibility Requirements: (As determined by the Department of Education)

1. Submit the Florida Financial Aid Application (FFAA) no later than August 31 after high school graduation,
2. Complete the 16 college-preparatory courses required for admission to a state university,
3. Achieve the required weighted GPA in the 16 college-preparatory courses per chart below,
4. Complete the required number of service hours per chart below, and
5. Achieve the required combined ACT® or composite SAT® score per chart below.

Type	16 High School Course Credits [1]	High School Weighted Bright Futures GPA	College Entrance Exams by High School Graduation Year (ACT®/SAT®)	Service Hours
FAS	4 - English *(three must include substantial writing)* 4 - Mathematics *(at or above the Algebra I level)* 3 - Natural Science *(two must have substantial laboratory)* 3 - Social Science 2 - World Language *(sequential, in same language)*	3.50	2019-20 Graduates: 29/1290 2020-21 Graduates: 29/1330	100 hours
FMS		3.00	2019-20 Graduates: 26/1170 2020-21 Graduates: 25/1210	75 hours

[1] The required coursework aligns with the State University System admission requirements found in Florida Board of Governors regulation 6.002.

Requirements to Receive an Award: (As determined by the postsecondary institution)

1. Evaluated by Office of Student Financial Assistance (OSFA) as meeting the initial eligibility requirements
2. Graduated with a standard high school diploma or its equivalent
3. Be a Florida resident and U.S. citizen or eligible noncitizen
4. Enroll as a degree- or certificate-seeking student at a Florida institution in at least 6 non-remedial semester credit hours

Renewal Requirements: (As determined by grade and hours submitted by the postsecondary institution)

1. Students must earn the number of credit hours based on the student's enrollment type per term, and
2. The renewal cumulative GPA requirements are outlined in the table below.

	Florida Academic Scholars (FAS)	Florida Medallion Scholars (FMS)
Minimum Cumulative GPA (unrounded and unweighted)	3.0	2.75

For detailed information, including other ways to qualify, please refer to the Bright Futures Student Handbook.

These eligibility requirements are subject to change with each legislative session.

The student is responsible for tracking application and award status online and ensuring that funding for an academic year is accurate by contacting their institution's financial aid office.

Last updated: 9/10/2019

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BIOGRAPHICAL SUMMARIES

ERIC ACOSTA

Education

Ed.D. Educational Policy, Planning, and Leadership K-12
College of William & Mary (2020)

Educational Specialist, Educational Leadership
Nova Southeastern University (1999)

Master of Education
Phillips University (1986)

Bachelor of Science, Social Studies Education
Florida International University (1995)

Experience

Miami-Dade County Public Schools
Administrative Director, Central Region Office (2016 - Present)
Principal, Hialeah-Miami Lakes Senior High School (2014 - 2016)
Principal, Palm Springs Middle School (2010 - 2014)
Assistant Principal (2000-2003, 2007-2010)
Teacher (1995 – 2000)

Related Training and Experience

Miami-Dade County Public Schools Certified Assessor Training Tool Trainer (2013 - present)
The McGraw-Hill Companies Regional Vice-President, Southeast United States (2006 - 2007)
The McGraw-Hill Companies District Manager, Florida (2006)
Glencoe/McGraw-Hill Sales Representative (2003 - 2006)
Miami-Dade County Public Schools Mentor Principal, Principal Inductees Program (2015 - 2016)
Miami-Dade County Public Schools Principal Trainer, “Money Does Matter” (2015 - 2016)
Miami-Dade County Public Schools Mentor Principal, iLead (2014 - 2015)
Miami-Dade County Public Schools District Allocation Committee (2011 – 2012, 2014 - 2015)
Miami-Dade County Public Schools Curriculum Liaison Committee (2011- 2012)
Miami-Dade County Public Schools Mentor Principal (2011 - 2013)
Florida International University Principal Leadership Development Program (2011)
Association of Latino Administrators and Superintendents (2010 – Present)
Florida Association of School Administrators (2014 - Present)
Dade Association of School Administrators (2000 – Present)

Professional Presentations

Guest Lecturer St. Thomas University Graduate School of Business, Miami, FL (2013 - 2015)

Awards and Honors

Miami-Dade County Public Schools Race to the Top Award (2011)
Miami-Dade County Public Schools District Assistant Principal of the Year Runner-Up (2009)
Miami-Dade County Public Schools Assistant Principal of the Year South Central Regional Center (2009)
Glencoe/McGraw-Hill Pacesetter Award (2004, 2005, 2006)
Glencoe/McGraw-Hill Golden Eagle Award (2004, 2005, 2006)
Miami-Dade County Public Schools Region V Sallie Mae Beginning Teacher of the Year (1995)

EVONNE S. ALVAREZ

Education

Ed.D. Educational Policy, Planning, and Leadership K-12
College of William & Mary (2020)

Master of Science, Educational Leadership
Nova Southeastern University (1999)

Bachelor of Arts, Behavioral and Social Science
University of Maryland, College Park (1993)

Experience

District Director Curriculum**,** School Choice and Parental Options, *Miami-Dade County Public Schools* (2018 - Present)
Principal, New World School of the Arts, Miami, FL (2012 - 2018)
Principal, South Miami Middle Community School Center for the Arts, Miami, FL (2010 - 2012)
Principal, Campbell Drive Middle School, Homestead, FL (2007 - 2010)
Assistant Principal, South Dade Senior High School, Miami, FL (2006 - 2007)
Assistant Principal, Citrus Grove Middle School Miami, FL (2005 - 2006)
Assistant Principal, Coral Gables Senior High School, Miami, FL (2002 - 2005)
Assistant Principal, Kinloch Park Middle School, Miami, FL (2002)
Teacher, Coral Gables Senior High School, Miami, FL (1997 - 2002)
Teacher, Allapattah Middle School, Miami, FL (1995 - 1997)

Related Training and Experience

Harvard University Reimagining Integration (RIDES) Institute (2019, 2020)
U.S. Department of Education Magnet Schools Assistance Program Project Director (2018 - present)
EA Educational Consultant & Partners, Consultant (2018 - present)
Miami-Dade County Public Schools Certified Assessor Training Tool (CATT) Trainer (2013 - present)

Professional Presentations

Alvarez, E. & Ortega, M. (2019). Presented at United States Department of Education Magnet Schools Assistance Program Grant Project Directors Meeting, Crystal City, VA.

Alvarez, E. (2019). *MSA National Certification: the five standards of Excellence, am I almost there? Integrating Magnet Themes with Career and Technical Education*. Presented at Magnet Schools of America Annual Conference, Baltimore, MD.

Alvarez, E. (2018). *Empowering Schools to plan, aim and obtain National Magnet School Standards of Excellence Certification*. Presented at Magnet Schools of America Annual Conference, Chicago, IL.

Service

Magnet Schools of America, Executive Board Member, Regional Director for Alabama, Florida, Georgia, Puerto Rico & U.S. Virgin Islands (2017 - present)
Magnet Schools of America, Chair for all Regional Directors (June 2019 - present)
Florida Guardian Ad Litem Program, Eleventh Judicial Circuit, Volunteer Child Advocate (2017 – present)

Awards and Honors

Alvah H. Chapman Jr. Organization Award of Excellence New World School of the Arts (2018)
Miami-Dade County Public Schools Principal of the Year District Runner Up (2018)
Dade Art Educators Association Paul Heithaus Outstanding Administrators Award (2014)
Magnet Schools of America School of Distinction Award for New World School of the Arts (2013, 2015 -2018)
Magnet Schools of America, National Certification, and National Demonstration School Award for New World School of the Arts (2017)
U.S. News & World Report Best High Schools Gold Medal Award (2013 - 2018)
Magnet Schools of America School of Excellence Award, New World School of the Arts (2014)
Miami-Dade County Public Schools Race to the Top Award (2011, 2012)
Magnet Schools of America School of Distinction Award for South Miami Middle School Center for the Arts (2011, 2012)
Miami-Dade County Public Schools High School Curriculum and Instruction Liaison Committee (2013 -2014)
Miami-Dade County Public Schools Middle School Curriculum and Instruction Liaison Committee (2008 - 2011)

GILBERTO D. BONCE

Education

Ed.D. Educational Policy, Planning, and Leadership K-12
College of William & Mary (2020)

Master of Science in Education
University of Miami, Coral Gables, Florida (1992)

Bachelor of Science, Chemistry and Physics Major
Troy State University, Troy, Alabama (1990)

Experience

Miami-Dade County Public Schools
Principal, South Miami Senior High School, Miami, FL (2006 - Present)
Principal, West Miami Middle School, Miami, FL (2003 - 2006)
Assistant Principal, Ponce de Leon Middle School, Coral Gables, FL (1999 - 2003)
Assistant Principal, Allapattah Middle School, Miami, FL (1994 - 1999)
Teacher, George Washington Carver Middle School, Miami, FL (1990 - 1994)
Teacher, Miami Senior High School, Miami, FL (1991)

Related Training and Experience

Miami-Dade County Public Schools Certified Assessor Training Tool Trainer (2013 - present)

Service

Boy Scouts of America Assistant Scout Master, Pack and Troop 575, Miami, Florida (2006 - 2017)

Awards and Honors

Miami-Dade County Public Schools Principal of the Year District Runner Up (2010)
Miami-Dade County Public Schools Central Region Principal of the Year (2010)
Council for Educational Change Leonard Miller Principal Leadership of the Year Finalist (2009)
Miami-Dade County Public Schools Science Teacher of the Year (1993)

MELANIE EILEEN MEGIAS

Education

Ed.D., Educational Policy, Planning, and Leadership K-12
College of William & Mary (2020)

Educational Specialist, Instructional Leadership
Nova Southeastern University (2017)

Master of Science, Teaching English to Speakers of Other Languages
University of Miami (1991)

Bachelor of Arts, Political Science
The George Washington University (1983)

Experience

Miami-Dade County Public Schools
Executive Director, Labor Relations (2018 - Present)
Principal, Rockway Middle (2011 - 2018)
Principal, North Miami Middle (2009 - 2011)
Administrative Director, Mathematics Education (2007 - 2009)
District Director, Administrative Staffing (2005 - 2007)
Principal, Miami Springs Elementary (2002 - 2005)
Assistant Principal (1996 - 2002)
Teacher (1987 - 1992)

Related Training and Experience

Miami-Dade County Public Schools Certified Assessor Training Tool, Trainer (2013 - present)
Miami-Dade County Public Schools, Executive Lead Principal (2017 - 18)
FIU Principal Leadership Development Program, Participant (2016 - 17)
FLDOE Commissioner's Leadership Academy, Participant/Facilitator in Training (2015 - 2017)
Harvard University Principal Leadership Institute Secondary School Reform (2011)

Professional Presentations

Megias, M. (2017). *School Culture*. Presented at Florida East Coast Technical Assistance Center Conference

Service

Dade Association of School Administrators, Executive Board Member (2005 - present)
William and Mary Educational Review Editorial Board, Lead Reviewer (2019 - present)
William and Mary Educational Review, Reviewer (2018 - 2019)

Awards and Honors

East Coast Technical Assistance Center Exceeding Expectations Rockway Middle (2016, 2017)
Magnet Schools of America School of Distinction Award for Rockway Middle School (2016)
Miami-Dade County Public Schools Race to the Top Award (2011, 2012)
Miami-Dade County Public Schools Central Region Assistant Principal of the Year (2000)

GUILLERMO MUÑOZ

Education

Ed.D. Educational Policy, Planning, and Leadership K-12
College of William & Mary (2020)

Master of Science, Educational Leadership
Nova University (1997)

Bachelor of Science, Education
Nova University (1992)

Experience

Miami-Dade County Public Schools
Principal, South Dade Middle School, Homestead, FL (2019 - Present)
Principal, Homestead Senior High School, Homestead, FL (2013 - 2019)
Principal, Westland Hialeah Senior High School, Hialeah, FL (2009 - 2013)
Principal, School for Advanced Studies, Miami, FL (2006 - 2009)
Principal, Miami Northwestern Senior High School, Miami, FL (2005 - 2006)
Principal, Brownsville Middle School, Miami, FL (2004 - 2005)
Assistant Principal, Miami Northwestern Senior High School, Miami, FL (1998 - 2004)
Teacher, Miami Coral Park Senior High School, Miami, FL (1996 - 1998)
Teacher, Hialeah Senior High School, Hialeah, FL (1994 - 1996)
Teacher, Kinloch Park Middle School, Miami, FL (1992 - 1994)

Related Training and Experience

Miami-Dade County Public Schools Certified Assessor Training Tool Trainer (2013 - present)

Professional Presentations

Muñoz, G. (2012). Presented at Woodrow Wilson Foundation Gathering on Early College Initiative, Philadelphia, PA.

Muñoz, G. (2012). *Breaking Ranks Showcase and Improving Student Performance*. Presented at National Association of Secondary School Principals (NASSP) Conference, Tampa, FL.

Service

Miami-Dade County Public Schools Athletic Eligibility Transfer Review Committee (AETRC) Committee (2004 - 2017)

Awards and Honors

Miami-Dade County Public Schools Principal of the Year (2016)
Florida Tax Watch Elite Principal Award Winner (2013)
Miami-Dade County Public Schools Race to the Top Award Recipient (2011)