END OF COURSE GEOMETRY EXAM RESULTS COMPARED WITH NATIONAL ACADEMY FOUNDATION (NAF) ENROLLMENT, GENDER, AND THE COST-EFFECTIVENESS OF THE PROGRAM IN A SELECTED SCHOOL DISTRICT: A TWO-YEAR STUDY

By

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To my dad, my mom, my husband, my two children and my family who are my team.
Thank you for being my cheerleaders.

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The desire to better oneself and empower others to do the same is the underlying reason I desired to be an educator. Although I work daily to help students seek a purpose, I have a support network that continue to uplift and remind me of my own purpose. I seek balance and I have vowed not to live to work but to work to live. Many people have influenced my decisions and have motivated me to achieve my goals but even more of an impact are those who remind me the true goals in life. As I worked on my doctoral coursework and research, I vowed not to entirely disrupt the most important thing in my life: the importance of family. However, my husband, J.R. Stalcup and my two sons, Brayden and Bryen Stalcup have supported me and have served as my cheerleaders throughout this process. Although we embarked on many adventures while I was in school, there were times that I had to devote to my studies. They were supportive, helpful, and my rock in times of need. Even when J.R. and I both were immersed in our studies, we believed that we were showing our children the importance of education. I wholeheartedly thank my mother, Karen Sweatlock, for her continuous unconditional support and love. She has believed in me from the beginning of my existence, along my educational path, my quest to be a better person, and continues to nurture my family. I thank her for giving me the praise that only a mother can give. Even though my father is amongst the angels, I thank John W. Sweatlock for his strength he gives me to keep going and for watching over me as I progress through my education, administrative career, and life on this earth. I know you are my guardian angel and watch over my children and ensure their safety. I wish to thank my mentors who always gave me opportunity and unwavering encouragement: Mr. Tim Kutz, Mr. Gary Brown, Mr. Ken Fairbanks, and Dr. Shari Huene-Johnson. I cannot thank the

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LIST OF ABBREVIATIONS AND DEFINITIONS

Career and Technical Education (CTE)	CTE provided students of all ages with the academic and technical skills, knowledge and training necessary to succeed in future careers and to become lifelong learners. In total, about 12.5 million high school and college students were enrolled in CTE across the nation. CTE prepared these learners for the world of work by introducing them to workplace competencies, and made academic content accessible to students by providing it in a hands-on context. In fact, the high school graduation rate for CTE concentrators was about 90% – 15 percentage points higher than the national average.[1]
Computer-Based Testing (CBT)	Many Florida statewide assessments are now being administered using a computer-based format. In 2015, the FSA Grades 8–10 ELA Writing, Grades 5–10 ELA Reading, Grades 5–8 Mathematics, Algebra 1 EOC, Geometry EOC, and Algebra 2 EOC were given in a computer-based format, with paper-based accommodations offered for eligible students. When taking the test on the computer, students make their answer choices using the mouse or keyboard, and they may use various CBT tools, such as the strikethrough tool or the highlighter tool, as they work. Once they have completed the test, they submit their answers electronically. Before exiting the assessment and submitting their responses, students are taken to a screen that identifies questions that are answered, unanswered, and marked for review.[2]
End-of-Course Exam (EOC)	Many Florida courses are required for graduation with a required passing score on the end-of-course culminating exam. These statewide assessments are now being administered and required for graduation as of this publication in the following subjects: Algebra 1 EOC and Geometry EOC.
Florida Standards Assessments (FSA)	With the Florida standards in place to help Florida students succeed, the Florida Standards Assessments (FSA) in English Language Arts (ELA), Mathematics, and end-of-course (EOC) subjects (Algebra 1, Algebra 2, and Geometry) served Florida students by measuring education gains and progress.[3]

[1] Career and Technical Education (2017). Advance CTE. https://www.careertech.org/cte

[2] Understanding Florida Standards Assessments Reports. (2015). Office of Assessment. Florida Department of Education. http://www.fldoe.org/core/fileparse.php/5663/urlt/UnderstandingFSAReports.pdf

[3] Florida Standards Assessments. (2016). Florida Department of Education. <http://www.fldoe.org/accountability/assessments/k-12-student-assessment/fsa.stml>

National Academy Foundation (NAF)	NAF: a national network of education, business, and community leaders who worked together to ensure high school students were college, career, and future ready.
Science, Technology, Engineering and Math (STEM)	STEM: an educational program developed to prepare primary and secondary students for college and graduate study in the fields of science, technology, engineering, and mathematics (STEM). In addition to subject-specific learning, STEM aimed to foster inquiring minds, logical reasoning, and collaboration skills.
T-score	The score that students received the first year the FSA assessment was administered. T scores were reported using a norm-referenced score scale known as a T score scale.[4]

[4] Understanding Florida Standards Assessments Reports. (2015). Office of Assessment. Florida Department of Education.
<http://www.fldoe.org/core/fileparse.php/5663/urlt/UnderstandingFSAReports.pdf>

Abstract of Dissertation Presented to the Graduate School
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Chair: R. Craig Wood
Cochair: Linda Eldridge
Major: Educational Leadership

The college and career ready student was the focus of major legislative discussion as well as policy and program implementation at the local school board levels. School grades were calculated partially based on post-secondary opportunities given to students while enrolled in high school. For this reason, numerous prescriptive programs to drive student success emerged in secondary schools such as the National Academy Foundation (NAF).

End of course Geometry exam scores correlating to enrollment in NAF Engineering courses were compared to determine the success in those EOCs compared to those students who were not enrolled in NAF engineering courses over a two-year period. Gender was also analyzed within engineering academy enrollment in eight southwestern high schools to determine performance variance and future recruitment initiatives. Cost-effectiveness of the program was determined to validate the expenditures of the NAF program for student benefit relating to performance on the Geometry end-of-course exam. The positive impact that NAF engineering enrollment

may play on performance of the Geometry EOC could be a precursor to market the measurable impact to students. Specifically, the students enrolled in NAF (as reported in this study) scored at means one level of proficiency higher than non-NAF engineering students (Level 4 to Level 3 in comparison). While gender did not show significant differences in the marginal means, NAF enrollment yielded a higher mean Geometry EOC score among males and females in the study. Immersion into STEM focused curricula was tied to critical thinking, decision-making, and connection to real-world applicable learning. The benefits of NAF Engineering course expenses were justified in the increase performance based on enrollment in the program.

CHAPTER 1
INTRODUCTION

The college and career ready student was the focus of major legislative discussion as well as policy and program implementation at the local school board levels. In the state of Florida, school grades were partially calculated based on post-secondary opportunities given to students while enrolled in high school such as industry certifications.[1] For this reason, numerous prescriptive programs to drive student success emerged in secondary schools such as the National Academy Foundation (NAF).[2] NAF grew from one NAF Academy of Finance in New York City to hundreds of academies across the country that focused on growing industries including: finance, hospitality & tourism, information technology, engineering, and health sciences. During the 2014-15 school year nearly 82,000 students attended 667 NAF academies across thirty-eight states, including DC and the US Virgin Islands. In 2014, NAF academies reported 97 percent of seniors graduated with 93 percent of those graduates that planned to go to college.[3] According to NAF, an academy helped increase school and district graduation rates and gave students the confidence to take charge of their futures and succeed in college, career, and beyond.[4] It is proposed that the NAF educational design was flexible enough for differing high schools and communities in size for successful implementation. NAF worked with high schools and school districts to

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[1] Accountability Update (2015). Florida Department of Education. <http://www.fldoe.org/core/fileparse.php/5637/urlt/AccoReportTechMeeting2016.pdf>

[2] "The NAF Educational Design" (2015). National Academy Foundation. www.naf.org

[3] Ibid.

[4] Ibid.

implement the NAF educational design into the school setting and provided the framework for the academies.[5] There were numerous academy programs carrying different brands and names including the Project Lead the Way[6] program to incorporate Science, Technology, Engineering, and Math (STEM) initiatives in schools.

NAF's educational design included four essential elements of practice: academy development & structure, curriculum & instruction, advisory board, and work-based learning. NAF reported that these elements build on each other to engage students, support school and district priorities, and gave businesses the opportunity to connect with students and offer internships.[7]

NAF academies were structured as small, focused learning communities that fit within and claimed to enhance high school systems, allowing NAF to become an integral part of a plan for higher achievement for a fee. However, the budget crisis facing many school systems placed increased pressure on any expenses that are not already part of the routine funding in a school system. NAF academies' total costs are under 5 percent of the costs per student in high school.[8] Even with NAF's promise of significantly improved college- and career-ready results, short-term budget considerations could diminish the ability of the school board to implement NAF

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[5] "The NAF Educational Design" (2015). National Academy Foundation. www.naf.org

[6] See www.pltw.org

[7] "The NAF Educational Design" (2015). National Academy Foundation. www.naf.org

[8] Ibid.

academies.[9] Project Lead the Way (PLTW) also ran as an ancillary program to facilitate the engineering programs. For this reason, this study implemented a cost-effective analysis in an attempt to justify NAF engineering expenses including the costs of PLTW professional development based on student performance. Grants, in-house technology resources, and donor finances provided the funding necessary to support the program's supplies and needed resources in the selected school district studied.[10]

NAF promoted open enrollment for its academies in order to maximize every student's chance at a successful future. NAF's claimed flexible structure encouraged teacher collaboration across subject areas and fostered personalization to meet student, school, district, and state needs and goals. NAF claimed that it provides a rigorous, industry-validated career-themed curriculum that incorporates current industry standards and practices, literacy strategies, and STEM integration while NAF's instructional practices foster cross-curriculum collaboration so students can make connections across subject areas.[11] The NAF curricula was created in partnership with industry professionals and designed around projects that help students acquire valuable workplace skills and see their education as a step toward long-term career options.[12] The program claimed to empower teachers to expand the boundaries of the classroom in non-traditional ways that ensured lessons have real-world application to growing

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[9] NAF Strategic Plan 2012-16.
www.socialimpactexchange.org/sites/www.socialimpactexchange.org/files/NAF%202012-16%20plan%20Final-2.pdf

[10] Career and Technical Education Director, Interview (2016). Career and Technical Education Director. Name and school district removed for Anonymity.

[11] "The NAF Educational Design." (2015). National Academy Foundation. www.naf.org

[12] National Academy Foundation. (2012). National Academy Foundation Strategic Plan 2012-2016. <http://www.socialimpactexchange.org>

industries. The advisory boards claimed to provide a bridge between schools and the workplace where businesspeople and community leaders volunteer on local advisory boards to play an active role in developing their future workforce by shaping talent in high school. In addition, advisory board members collaborate with educators to inform curricula and help organize work-based learning activities within the community. NAF claimed that advisory boards gave students the opportunity to build relationships with mentors early and learn from successful adults. Work-based learning connected the classroom to the workplace and the workplace to the classroom. This instructional strategy worked to provide students with a well-rounded skill set that goes beyond academics and included the soft skills needed to succeed in college and the working world. NAF's approach to work-based learning was centered on a continuum of work-based learning experiences beginning with career awareness activities, progressing to career exploration activities, and culminating in career preparation activities, including internships.[13] Business people guest speak in classrooms, host college and career skills workshops, and take part in mock interviews. Students had the opportunity to tour worksites, network with, and shadow business professionals. In addition, work-based learning culminated in an internship that allows students to apply their classroom skills and learn more about what it takes to succeed.[14]

Statement of the Problem

High-stake tests determining graduation were highly valued by administrators, teachers, parents and students due to the implications and meaning of the scores. High

[13] "The NAF Educational Design." (2015). National Academy Foundation. www.naf.org

[14] Ibid.

stakes tests were described as examinations necessary for graduation, to enter in a specific educational program or university, to gain a scholarship or proving a determined proficiency for an application.[15] In the state of Florida, Geometry End-of-course exams met this requirement as a required course with high-stakes attached to the scores.

This study focused on the correlation between student enrollment in National Academy Foundation (NAF) engineering courses and their respective grades in a Geometry End-of-Course (EOC) exam over a two-year period. Determining the cost-effectiveness of the program was instrumental since school districts spent a great deal of money in stipends to NAF teachers' professional development, NAF program supplies as well as NAF engineering materials. The Science, Technology, Engineering and Math (STEM) initiative and academy enrollment was heavily marketed to students and was included in district and school goals in order to recruit an unbiased population selection for the NAF programs with regard to gender. End of course Geometry exam scores correlating to enrollment in NAF Engineering courses were analyzed to determine the success in those EOCs compared to those students who were not enrolled in NAF engineering courses. Success among gender subgroups in each southwestern Florida high school was also studied to determine future recruitment initiatives.

Purpose of the Study

The purpose of this study was to determine if there were a positive relationship between enrollment in the National Academy Foundation Engineering program and

[15] Hatice Kumandas and Ömer Kutlu. (October 2015). "High Stakes Tests," *Journal of Educational Sciences Research*. International E-Journal. Vol 5, No.2.

achievement on the Geometry End of Course test that was used as standards for graduation in Florida. The purpose of the study also served to analyze the performance of the gender subgroups. Two years of data were analyzed to determine Geometry EOC performance and NAF enrollment. The cost-effectiveness of the program was analyzed to determine the significance of the EOC math exam results of NAF (Engineering program) enrolled students versus non-enrolled students. Determining cost-effectiveness based on testing correlated to political motivations since test performance was a measure that was used for accountability purposes. Beyond controlling teaching and learning, tests served as the accountability tool that ensured taxpayers' money was allocated to valid expenditures.[16]

Each high school in the southwestern district of study had an engineering academy. Geometry end of course exam scores correlating to NAF Engineering courses were analyzed and hypotheses were formed to determine areas of weakness in implementation and success among gender subgroups in each southwestern Florida high school selected. Although test scores were only one measure of student achievement and school success, the results of these standardized tests were the most publicized. In Florida, End-of-Course (EOC) tests at the high school level were the standardized tests used by the Florida Department of Education (FLDOE) to measure school success annually during the period of the study.

The questions considered the performance Geometry EOC test results for all students enrolled in NAF and those not enrolled as well as considered the results for students by gender (enrolled and not enrolled in NAF).

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[16] George Madaus and Michael Russell. (2010-11). "Paradoxes of High-Stakes Testing," *Journal of Education*, Vol. 190, Nos. 1-2.

1. Did students who participated in the NAF program have higher EOC scores than students who did not participate in NAF?

2. Did these results hold true for students regardless of their gender?

3. Did NAF enrollment demonstrate cost-effectiveness of the program based on these results?

All high schools in one southwest Florida school district were selected as research sites. Student End of Course testing data were collected along with NAF participation data from each of the high schools. Data were analyzed to determine if there were a statistically significant relationship between participation in NAF and achievement on the Geometry End of Course test. The independent variable was the students' participation in the NAF program or non-participation, while the dependent variables were the Geometry end-of-course exam scores of both groups of students, and gender was the covariate.

The hypothesis of this study indicated that enrollment in National Academy Foundation over two consecutive academic semesters had a statistical impact upon the end-of-course math achievement examination for 9^{th} and 10th grade students enrolled in Geometry. The findings resulting from the research question was hypothesized to indicate a positive relationship between enrollment in NAF and math achievement; while non-enrollment scores were deemed lower or inconsistent.

Organization of the Study

All southwestern high schools in the district of varying socio-economic populations were chosen. The design could be duplicated within different districts in different locations given demographic consideration. The study took anonymity precautions in the selection samples and references to schools.

The high schools in a Florida district were selected as research sites. Second, student End of Course testing data were collected along with NAF enrollment data from each of the schools involved. Third, the data were analyzed as a whole as well as disaggregated by gender to determine if there were a statistically significant relationship between participation in the NAF academy and achievement on End of Course tests. Cost-effectiveness was determined by the statistically significant results of the research questions:

Research Questions

1. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2014-15?

   Ho: EOC Geometry scores did not differ by group NAF enrollment vs. Non-NAF enrollment (Independent variable Group 1 vs. Group 2) in 2014-15.

   Ha: EOC Geometry scores differed by (independent variable Group 1 vs. Group 2) NAF enrollment vs. Non-NAF enrollment in 2014-15.

2. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2014-15?

   Ho: EOC Geometry scores did not differ by gender when enrolled in NAF Engineering or not enrolled in NAF Engineering. (independent variable: group 1 vs. group 2) in 2014-15.

   Ha: EOC Geometry scores differed by gender (independent variable: group 1 vs. group 2) in 2014-15.

3. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2015-16?

   Ho: EOC Geometry scores did not differ by group NAF enrollment vs. Non-NAF enrollment (Independent variable Group 1 vs. Group 2) in 2015-16.

   Ha: EOC Geometry scores differed by (independent variable Group 1 vs. Group 2) NAF enrollment vs. Non-NAF enrollment in 2015-16.

4. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2015-16?

Ho: EOC Geometry scores did not differ by gender when enrolled in NAF Engineering or not enrolled in NAF Engineering (independent variable: group 1 vs. group 2) in 2015-16.

Ha: EOC Geometry scores differed by gender (independent variable: group 1 vs. group 2) in 2015-16.

5. Did NAF enrollment demonstrate cost-effectiveness of the program based on these results of the previous research questions?

Ho: NAF Engineering enrollment was not significant on Geometry EOC score results thus not demonstrating cost-effectiveness of the program.

Ha: NAF Engineering enrollment was significant on Geometry EOC score results thus demonstrating cost-effectiveness of the program.

Data Analysis Plan

To examine the research question, a two-way analysis of variance (ANOVA) was conducted to assess if mean differences existed. The two-way ANOVA was an appropriate statistical analysis when the purpose of research was to compare two or more discrete groups on a continuous dependent variable that was measured more than once. For this research, the continuous dependent variables were the EOC Geometry test; the independent variable had the following groups (NAF Engineering Enrollment vs. Non-NAF Engineering Enrollment and Female NAF Engineering vs. Male NAF Engineering vs. Female Non-NAF Engineering vs. Male Non-NAF Engineering). The ANOVA used the F test to make the overall comparison on whether group means differ. If the obtained F were larger than the critical F, the null hypothesis was rejected. The results of the mixed model ANOVA presented findings for the main effect and evaluated the overall differences by time (within-subjects) and also separately by group (between-subjects). The dependent variable was approximately normally distributed for each level of the independent variable. For the purpose of the research, a level of significance of 0.05 was selected in order to determine whether to accept or reject the null hypotheses.

Eight high schools were selected in a Southwest Florida district. Since the results of End of Course test scores for NAF enrollees were compared against those for non-enrollees, there were two sets of data that were collected: a list of student scores on End of Course tests and a list of students who were participating in NAF enrolled academies at the time those scores were achieved. In order to compare the results by gender, that data were compiled to differentiate those results. Two years of NAF enrollment and EOC Geometry scores (2014-15 and 2015-16) were collected and analyzed separately due to the changing scale scores implemented by the Florida Department of Education Office of Assessments. Since numerous NAF academies were implemented in each school and the Engineering Academy was consistent across all schools, engineering was only selected.

The 2014-2015 and 2015-2016 End of Course test scores were utilized for the data collection. To ensure appropriate and meaningful data, only scores from the academic area that have served as graduation exit standards for high school students (Geometry) were utilized.

After determining which data were needed and the schools involved, the actual data collection was compiled through the district data-warehouse site through written approval.[17] Once the necessary data were collected, students were anonymously compiled into a master spreadsheet with columns enrolled Engineering program NAF student (Y or N), test score, and the gender of each student.

[17] See Appendix A.

Assumptions and Limitations

It is an assumption that improving EOC results were extremely important for high schools in Florida. Part of the state and federal annual measures for every high school were based on the results of EOC tests. These tests were also used as exit standards for students graduating high school.[18]

In 2013, Governor Rick Scott publicized the "It's Your Money Tax Cut Budget" that proposed to fund education at highest total and state funding levels in Florida history for Florida's K-12 public schools and the Florida college system. The funding listed $18.8 billion for Florida's K-12 public schools. Governor Rick Scott indicated, "Education is one of the primary economic engines in this state."[19]

It was recognized and assumed that Florida's students must be given the tools and resources they need to succeed in college, career and life.[20] For this reason, the investment in college and career readiness became a top discussion among district leaders and budgets and school improvement plans must address this goal.

In 2015, the Florida Legislature approved a $20.15 billion K-12 budget that equated to $7,178 per student, reaching the total Governor Rick Scott outlined in his campaign promise.[21] His campaign also recognized that additional funding and other highlights were needed and therefore, proposed: $8.4 million for professional

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[18] "Graduation Requirements for Florida's Statewide Assessments." (February 2014). Florida Department of Education. Office of Assessment. www.fldoe.org/core/fileparse.php/7764/urlt/GradRequireFSA.pdf

[19] Rick Scott. (June 2014). "Gov. Scott Signs 'The It's Your Money Tax Cut Budget'" Florida Government News Releases. <www.flgov.com>

[20] Ibid.

[21] "Let's Keep Florida Learning." (2014). <http://www.rickscottforflorida.com/wp-content/uploads/2014/11/Let%E2%80%99s-Keep-Florida-Learning.pdf>

development for principals and assistant principals; $5 million for teacher training and technical assistance related to the implementation of state standards; $2 million increase to expand the state portion of the dollar-for-dollar match of private donations from public school district educational foundations; and $10 million for performance funding ($5 million new funds) to Florida colleges based on an increase in students earning industry certifications in high-skill/high-wage Florida occupations as specified in the most recent Florida Statewide Targeted Occupations List.[22] Although these proposals were slow to implement, the delivery outlined the focus on necessary educational funding to advance the quality of educational programs and training. A limitation of the study stemmed from the allocated grant monies, technology resources that were used for the NAF Engineering program as these dollars may have been allocated elsewhere if another program of interest existed for those students.

The National Academy Foundation served as a tool that assisted the local school board to prioritize federal and state STEM (Science, Technology, Engineering and Math) initiatives. It was a limitation that schools that may be STEM certified could possibly yield higher performing students; however, the study did not focus on STEM certification nor identify STEM certified schools. Several academy and career-focused organizations such as Project Lead the Way (PLTW) were also a tool that fueled the STEM initiatives and were fully implemented in each school of the study.

[22] Rick Scott. (June 2014). “Gov. Scott Signs The ‘It’s Your Money Tax Cut Budget’” Florida Government News Releases. <www.flgov.com>

CHAPTER 2
REVIEW OF THE LITERATURE

Performance tests have been tied to evaluation throughout history. In 200 BC, the Chinese used tests to help eliminate patronage and open access to the civil service. The Dead Sea scrolls describe the use of tests by the Qumran community to determine when a man was ready to become a formal member of the community. England, France, and Italy, among other nations, have used tests to ensure that students acquire certain skills and establish standards of performance. In Fifteenth-Century Italy, tests were used to hold teachers accountable for student learning. Since then, policy-makers have used tests to hold students and schools accountable and allocate scarce resources.[1]

However, these various testing policies were not meant to be punitive. Instead, these policies were, and continue to be, sincere attempts to address perceived problems in education. Policy-makers were attracted to testing as a solution to problems in society and education since test performance is a quantitative measure. Policy-makers realized they could not directly control instruction in classrooms, but they could indirectly influence instruction by attaching rewards or sanctions to the results of mandated tests.[2]

The National Commission on Testing and Public Policy described how pressure to improve scores on reading and math tests could narrow teaching to test preparation. The Commission warned that the high stakes attached to test use were ". . . driving

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[1] George Madaus and Michael Russell. (2010-11). "Paradoxes of High-Stakes Testing," *Journal of Education*, Vol. 190, Nos. 1-2.

[2] Ibid.

schools and teachers away from instructional practices that would help to produce critical thinkers and active learners."[3] This sentiment was quite important to evaluate the importance and cost-effectiveness of academy enrollment. Applicable skills and cross-curricular instruction could drive learning back to producing those critical thinkers and active learners that the career fields needed.

History of Education Accountability

Eamon DeValera, the Prime Minister of Ireland, expressed the logic behind using tests to hold teachers, students, and schools accountable. Proposing a system of certification examinations at the end of primary school, he argued successfully before Parliament in 1941:

> … if we want to see that a certain standard is reached and we are paying the money, we have the right to see that something is secured for that money. The ordinary way to test it and try to help the whole educational system is by arranging our tests in such a way that they will work in a direction we want.[4]

"Like many of today's policymakers, DeValera believed that tests provide the evidence that determines whether taxpayers' money was well spent. This reasoning was reflected clearly in President Bush and President Obama's reliance on tests to evaluate the success of educational programs. This use of tests to measure the outcome of education reflected a larger belief in the use of metrics to determine the success of any policy."[5]

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[3] George Madaus and Michael Russell. (2010-11). "Paradoxes of High-Stakes Testing," *Journal of Education*, Vol. 190, Nos. 1-2.

[4] Ireland. Dail Eireann. (1941). Parliamentary Debates, Col 1119.

[5] George Madaus and Michael Russell. (2010-11). "Paradoxes of High-Stakes Testing," *Journal of Education*, Vol. 190, Nos. 1-2.

Madaus and Russell claimed that there were three predictable ways that a high-stakes test adversely affected teaching and learning as seen throughout history, in recent research, and in literature of all genres. First, teachers gave greater attention to tested content and decreased focus on non-tested content that narrowed the content and skills taught and learned within a course. Second, a high-stakes test prevented time and coverage from other non-tested disciplines, thus narrowing the curriculum across subjects. Third, the content and skills covered on the high-stakes tests at the upper grades displaced the content and skills of non-tested lower grades, which altered the curriculum across grade levels.[6]

The debate over the use of tests in the development of policy was a debate over what results were desired from schools. It was a debate over educational values and competing educational philosophies, and it was about a means and ends. It was not a debate on technical matters related to testing. Madaus and Russell indicated that the proper role of testing was in question.[7] Whether the test results indicated success beyond high school, the tests placed added stress on stakeholders. Infiltrating standards into career or academy coursework or providing an applicable course utilizing student ability and career pathways, tests could begin to determine cost-effectiveness in a greater capacity.

Florida End-of-Course Testing

The Florida End-of-Course (EOC) Assessments measured student achievement of the Next Generation Sunshine State Standards (NGSSS), which specified the

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[6] George Madaus and Michael Russell. (2010-11). "Paradoxes of High-Stakes Testing," *Journal of Education*, Vol. 190, Nos. 1-2.

[7] Ibid.

challenging content Florida students were expected to know and be able to do. On December 19, 2011, the State Board of Education approved the Achievement Levels for FCAT 2.0 Reading, Mathematics, and the Algebra 1 EOC Assessment. On December 12, 2012, the State Board approved the Achievement Levels for FCAT 2.0 Science and the Biology 1 and Geometry EOC Assessments. On January 21, 2014, the State Board of Education approved Achievement Levels for the U.S. History EOC Assessment and established FCAT 2.0 and EOC assessment passing scores. The passing score on FCAT 2.0 Reading, Mathematics and Science and each Florida EOC Assessment was the minimum score in Achievement Level 3, and the passing score on FCAT 2.0 Writing was a score point of 3.5. These passing standards were consistent with the 2014-2016 proficiency standards used for Florida's accountability system. The Achievement Levels defined the level of success a student had with the NGSSS on the FCAT 2.0 and Florida EOC Assessments. The Achievement Level Policy Definitions applied to all FCAT 2.0 and EOC assessments and ranged from 1 (lowest) to 5 (highest).[8] See Table 3-2 through 3-5 for Geometry scores and range levels and Florida End-of-Course Assessments Achievement Level Policy Definitions.

The Florida Standards in Mathematics and English Language Arts were approved by the Florida State Board of Education in February 2014 and were implemented in grades K–12 in the 2014–2015 school year. All Florida schools taught the Florida Standards, and students were assessed through the statewide Florida Standards Assessments (FSA). Data from the FSAs provided information to parents,

[8] FCAT 2.0 and Florida EOC Assessment. (February 2014). Florida Department of Education. Office of Assessment. <http://www.fldoe.org/core/fileparse.php/3/urlt/achlevel.pdf>

teachers, policy makers, and the general public regarding how well students were learning the Florida Standards.[9]

The Florida Standard Assessment (FSA) End-of-Course exams (EOC) were computer-based tests (CBTs).[10] Each assessment was administered in two 90-minute sessions with one session per day over two days. There were multiple forms of the assessment, with a maximum of sixty-eight items on each test form. Six to ten of these items were field test items and were not used to calculate student scores. Students registered for Geometry, Geometry Honors, IB Middle Years Program Geometry Honors (not offered in this district's courses at the time of the study) and Pre-AICE Mathematics 2 (not offered as of the study)[11] were those required to take the Geometry exam. The Geometry EOC tested the following concepts:

- Congruence, Similarity, Right Triangles, and Trigonometry: Students understand congruence and similarity in terms of transformations. They prove and use geometric theorems. They demonstrate geometric constructions. They define trigonometric ratios. They solve problems involving right triangles. They use congruence and similarity criteria for triangles.
- Circles, Geometric Measurement, and Geometric Properties with Equations: Students prove and apply theorems about circles. They find arc lengths and areas of sectors. They derive the equation of a circle. They use coordinates to prove theorems and to solve problems algebraically. They explain and use volume formulas.

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[9] Understanding Florida Standards Assessments Reports. (2015). Office of Assessment. Florida Department of Education. http://www.fldoe.org/core/fileparse.php/5663/urlt/UnderstandingFSAReports.pdf

[10] Paper-based versions (regular print, large print, braille, and one-item-per-page) are provided for students with disabilities who cannot access assessments on the computer, as specified in their individual educational plans (IEPs) or Section 504 plans. CBT accommodations (e.g., text-to-speech) are available for students whose IEPs indicate these accommodations.

[11] Florida Department of Education. (November 2014). Bureau of K-12 Student Assessment. 2014-15 FSA EOC Fact Sheet. <http://www.fldoe.org/core/fileparse.php/5423/urlt/FSAEOCFS2014-15.pdf >

- Modeling with Geometry: Students apply geometric concepts in modeling situations.[12]

For the first administration, students received two performance indicators: a T score and a percentile rank. The T score was a score on a scale of 20-80 with approximately 50 as the statewide average. Students also received a percentile rank, showing how they performed on each grade level/subject area test compared to all other students in Florida who took the same test. After achievement-level cut scores were established, districts received 2014-2015 FSA test results retrofitted to reflect student performance on the new score scale. The success a student had achieved with the Florida Standards was assessed by FSA ELA and Mathematics assessments and was described by Achievement Levels that range from 1 (lowest) to 5 (highest). Level 3 indicates satisfactory performance. The level of performance required to score in each achievement level was established prior to the spring 2016 administration.[13]

Achievement level cut scores for FSA assessments were adopted in State Board of Education Rule 6A-1.09422, Florida Administrative Code, in January 2016. Level 3 was the passing score for each grade level and subject. The ranges included Level 3 (499-520) with 499 being the passing score; Level 4 (522-532) and Level 5 (544-575). Students who entered grade 9 in 2014-15 and beyond need to pass the FSA Algebra 1 EOC assessment for graduation purposes, and students must earn passing scores on the Geometry and Algebra 2 EOC assessments to earn a standard diploma with a

[12] Understanding Florida Standards Assessments Reports. (2015). Office of Assessment. Florida Department of Education. http://www.fldoe.org/core/fileparse.php/5663/urlt/UnderstandingFSAReports.pdf

[13] Florida Standards Assessments. (January 2016). 2015-16 Algebra 1, Algebra 2, and Geometry End-of Course Assessments Fact Sheet. http://www.fldoe.org/core/fileparse.php/5663/urlt/FSAEOC1516.pdf

scholar designation. Scores for spring 2015 Geometry were reported on a T-score scale.[14] Achievement level cut scores for FSA EOC assessments were established in January 2016.

Academy Schools, Charters and Imbedded Academy Programs

It is widely acknowledged that there is a clear mismatch between the social and private returns to education; therefore, reform within existing schools to include focused academies, US Charter schools, and Academy schools in England had taken shape.[15] Career academies, after more than four decades of development and three decades of evaluation, had been found by a conclusive random-assignment study to be effective in improving outcomes for students during and after high school.[16] Career academies had therefore become the most durable and best-tested component of a high school reform strategy to prepare students for both college and careers in the United States. The number of career academies had expanded rapidly, in part because academies have been found to be effective, and in part because they embodied ideas promoted by several major high school reform movements.[17]

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[14] Florida Standards Assessments. (January 2016). 2015-16 Algebra 1, Algebra 2, and Geometry End-of Course Assessments Fact Sheet. < http://www.fldoe.org/core/fileparse.php/5663/urlt/FSAEOC1516.pdf>

[15] Andrew Eyles and Stephen Machin. (Dec. 14, 2016). “Academy schools and the transformation of the English education system.” Oxford University Press. <https://blog.oup.com/2016/12/academy-schools-english-education-system/>

[16] David Stern, Charles Dayton, and Marilyn Raby. (February 2010).”Career Academies: A Proven Strategy to Prepare High School Students for College and Careers” Career Academy Support Network. University of California at Berkley. < https://casn.berkeley.edu/resource_files/Proven_Strategy_2-25-1010-03-12-04-27-01.pdf>

[17] Ibid.

In England, there was a recognized need to reform programs with the focus on academies.[18] A study by Eyles, Hupkau, and Machin used a quasi-experimental research design and estimated the causal effect of attending one of ninety-four sponsored academies that opened prior to September 2008 on pupil performance. To account for the fact that schools that became sponsored academies were below the national average in terms of test score performance prior to conversion, they compared outcomes for pupils attending academies that converted between September 2003 and September 2008 with those attending schools that would later convert between September 2009 and September 2010.[19] Looking at the characteristics of these two sets of schools before the start of the program, Eyles, Hupkau, and Machin found that they were balanced in terms of test score performance and the demographic make-up of their students. The result of this study suggested that on average, a student attending a sponsored academy between 2002 and 2009, scored 0.10 of a standard deviation higher in their end of school (Key Stage 4 exams) than a comparable pupil attending a school that would later gain academy status. The results were more pronounced the longer a student spent in an academy where those who spent four years in an academy gained 0.3 standard deviations on their peers who attended similar schools. The key stage 4 achievement gap between girls and boys was approximately 0.2 of a standard deviation while the gap between those eligible for free school meals and those who were not was approximately 0.75 of a standard deviation. In addition to short-term

[18] Andrew Eyles and Stephen Machin. (Dec. 14, 2016). "Academy Schools and the Transformation of the English Education System." Oxford University Press.<https://blog.oup.com/2016/12/academy-schools-english-education-system/>

[19] Andrew Eyles, Claudia Hupkau, Stephen Machin. (July 2016). "Academies, Charter and Free Schools: Do New School Types Deliver Better Outcomes?" *Economic Policy*, Volume 31, Issue 87, Pages 453–501, <https://doi.org/10.1093/epolic/eiw006>

gains, positive effects were found in academy attendance on the probability of staying on in education and entering a degree program. Since 2010, the academies program in England had expanded at a rapid rate with well over 60 percent of secondary schools having gained academy status.[20] The freedoms afforded to academy schools also surrounded around curriculum changes that could also offer career-based training. Fifty-seven percent of 720 academies indicated that changes in the curriculum were linked to the improved attainment and 29 percent indicated that this was the most important change made. Other conditions were noted with only a change in leadership (31 percent) as the other most important change and 55 percent indicated that the change in leadership attributed to improved attainment.[21]

To bridge the academy school in England to those in the United States, they operate similarly to charter schools in the United States. Historically, education in England had been a centralized process: local educational authorities (LEAs) responsible for state education received funding from the central government, which they then distributed to schools under government control, typically according to school size. In the early 2000s this changed when the Labor government began the academies program that gave control of some secondary schools, which were perceived to be failing, to private sector 'sponsors.' These sponsored academies were state-funded schools, but had little restrictions on how they spent money; furthermore, the school's governing body, which was appointed by the sponsor running the school,

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[20] Andrew Eyles, Claudia Hupkau, Stephen Machin. (July 2016). "Academies, Charter and Free Schools: Do New School Types Deliver Better Outcomes?" *Economic Policy*, Volume 31, Issue 87, Pages 453–501, <https://doi.org/10.1093/epolic/eiw006>

[21] Ibid.

had much greater autonomy from local authority control than the governing bodies of other state-funded schools. By January 2010 there were 203 sponsored academies in existence, all of which were free to exercise a large number of freedoms – these include hiring and firing of staff, being able to diverge from the national curriculum, set performance management system for teachers, and outsource services previously provided by the LEA.[22]

English academies, charter schools, or career academies embedded into public or private schools were seeking reform to improve schools. Specifically, career academies were one of the very few educational models that developed “National Standards of Practice” to encourage continuous improvement. These “National Standards of Practice" were adopted by many existing career academies and led to improvements across the field.[23] As funding for education became tighter and funding partners demand greater effectiveness and efficiency, these standards of practice should be used to guide the development and implementation of programs and promote a cycle of continuous improvement. The “National Standards of Practice” focus on key functions such as: mission and goals; professional development; curriculum and leadership; employer, postsecondary, and community involvement; and student assessment. Standards provide specific guidance to programs.[24] For example, they ensure that career academies were open to any student. They specify that curriculum

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[22] Andrew Eyles, Claudia Hupkau, Stephen Machin. (July 2016). “Academies, Charter and Free Schools: Do New School Types Deliver Better Outcomes?” *Economic Policy*, Volume 31, Issue 87, Pages 453–501, <https://doi.org/10.1093/epolic/eiw006>

[23] Ibid.

[24] Ibid.

was sequenced, integrated, relevant, and met college entrance requirements. Standards provided assurances that students have options for dual credit with two- and four-year colleges, as well as work- and community-based service learning options. They also required that teachers were credentialed and provided with ongoing training in the academy structure, curricular integration, student support, and employer involvement.[25]

STEM, CTE Initiatives and Equity in Programs

The question of what defines STEM (Science, Technology, Engineering, and Math) existed because of the many different approaches of research and education initiatives that have been a focus to compete globally. As the US federal government made STEM a top priority in funding multiple agencies carrying the STEM initiative had been competing for these dollars.[26] STEM programs were established as joint ventures between government, businesses, institutions of higher education, parents, and existing K-12 school systems especially as the government forged ahead to reform science and math education.[27] To accomplish these collaborations, centers and programs with emphasis on STEM were formed to tackle this initiative of transforming the current educational paradigm toward a STEM education perspective.[28] Project Lead the Way

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[25] Betsy Brand. (November 2009). “High School Career Academies: A 40-Year Proven Model for Improving College and Career Readiness. The National Career Academy Coalition.” <http://www.aypf.org/documents/092409CareerAcademiesPolicyPaper.pdf>

[26] Jo Handelsman and Megan Smith. (February 2016). “STEM for All.” The White House: President Barack Obama. https://obamawhitehouse.archives.gov/blog/2016/02/11/stem-all.

[27] Jonathan M. Breiner, Shelly Sheats, Carla C. Johnson, and Catherine M. Koehler. (January 2012). “What Is STEM? A Discussion About Conceptions of STEM in Education and Partnerships.” *School Science and Mathematics*. Volume 112, Issue 1, pages 3–11, http://onlinelibrary.wiley.com/doi/10.1111/j.1949-8594.2011.00109.x/epdf

[28]Ibid.

(PLTW), National Academy Foundation (NAF), Ford Next Generation Learning, National Career Academy Coalition were among the copious organizations formed to establish programs and resources to answer to the government STEM reform.

Project Lead the Way (PLTW) specifically was analyzed in several studies to establish the impact of project-based learning and the impact on math test scores. One study by Bottoms and Anthony[29] of the Southern Regional Education Board (SREB), the academic outcomes of 274 high school students who took two or more PLTW courses were compared with a control group consisting of students who were selected based on a stratified random sample of 274 students (using gender, ethnicity, and parental education level) who took career/technical education (CTE) courses. Both groups of students participated in SREB's High Schools that Work (HSTW) program. The authors compared a snapshot of results for an assessment that was aligned with the National Assessment of Educational Proficiency (NAEP) and that had subtests for mathematics, science, and reading, and found that PLTW students scored significantly higher on all three subtests than the CTE control group. This study also took into consideration that higher performing students may have made up the PLTW group and enrolled in more science and math courses than the CTE control group.[30] In spite of the fact that traditionally lower-performing students were enrolled in PLTW courses in higher numbers, students who participated in PLTW were more prepared for higher education. Specifically and in comparison to matched, non-PLTW students, PLTW students scored

[29] Gene Bottoms and Kimberly Anthony. (2005). "Project Lead the Way: A Pre-Engineering Curriculum that Works."
Southern Regional Education Board. http://publications.sreb.org/2005/05V08_Research_PLTW.pdf

[30] Ibid.

higher on the state's mathematics assessment, a higher percentage met the state's minimum Mathematics standard, and a higher percentage met the college-ready Mathematics standard.[31]

In a subsequent study by Bottoms and Uhn, where PLTW students were defined as those who took three or more PLTW courses, they observed a similar pattern of results: 292 PLTW students scored significantly higher, on average, on the mathematics and science subtests (but not reading) than their CTE peers.[32]

A study by Tran and Nathan used a very small sample of seventy PLTW students, students who took one or more PLTW courses during the 2007-08 school year, and compared their academic performance on a state assessment in mathematics and science to 70 students in a matched control group. Students in the control group were hand matched with the PLTW students based on Grade 8 mathematics and science performance, gender, and economic disadvantage status. Using a regression model, they found that PLTW students scored significantly lower in mathematics than their non-PLTW peers, but similarly to their peers in science. Tran and Nathan could not determine a definitive conclusion on the effects of enriched integration and the amount of exposure to the PLTW curriculum because the sample size for this analysis was relatively small.[33]

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[31] James P. Van Overschelde. (2013). "Project Lead The Way Students More Prepared For Higher Education," *American Journal of Engineering Education*, Vol. 4, No. 1. http://files.eric.ed.gov/fulltext/EJ1057109.pdf

[32] Gene Bottoms and John Uhn. (2007). "Project Lead the Way Works: A New Type of Career and Technical Program." *Southern Regional Education Board*, Atlanta, GA.

[33] Natalie Tran & Mitchell Nathan. (2010). "Pre-College Engineering Studies: An Investigation of the Relationship Between Pre-College Engineering Studies and Student Achievement in Science and Mathematics." *Journal of Engineering Education*, 92(2), 143-157.

The Department of Chemical and Biochemical Engineering at the University of Iowa implemented a study of the impact of PLTW on achievement outcomes in Iowa. This study used Iowa's statewide longitudinal data system to follow multiple cohorts of PLTW participants and nonparticipants from 8th grade into secondary education. The findings indicated that PLTW participants were more likely to be white, male, and perform in the upper quartile in mathematics and science prior to PLTW enrollment. This study also found statistical evidence that PLTW increased mathematics or science scores on the Iowa Test of Educational Development by 5 points which corresponds to roughly half a grade level.[34]

Van Overschelde gathered student-level data about students who participated in PLTW courses in secondary grades, as well as matched non-PLTW students, obtained from the Texas Education Research Center. The study indicated the cohort group was significant with a higher percentage of PLTW students meeting the minimum state standard (91.2 percent) than the matched control group (90.2 percent).[35]

Project Lead the Way was one program that stressed industry-based learning; thereby focusing on STEM programs to increase performance and college-ready students. Legislatures allocated billions of dollars into this enterprise while teachers in the K-12 system were expected to teach STEM to their students. Businesses were investing in the future employment pipeline where the students were the product of

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[34] David Rethwisch, Melissa Chapman Haynes, Soko S. Starobin, Frankie Santos Laanan, and Tom Schenk (2012). "A Study of the Impact of Project Lead the Way on Achievement Outcomes in Iowa," American Society for Engineering Education. BePress. Access to the study available: http://ir.uiowa.edu/cgi/viewcontent.cgi?article=1033&context=aseenmw2014

[35] James P. Van Overschelde. (2013). "Project Lead The Way Students More Prepared For Higher Education," *American Journal of Engineering Education*. Texas State University, Vol. 4, No. 1. <http://files.eric.ed.gov/fulltext/EJ1057109.pdf>

these efforts.[36] Project Lead the Way (PLTW) added rigor to traditional technical and academic programs through project- and problem-based learning.

PLTW began in the 1997–1998 academic year, affiliated with the High Schools That Work (HSTW)[37] project in 1999, and served over 1,300 schools in forty-five states in 2015.[38] PLTW courses were designed to provide students with opportunities to understand the scientific process, engineering problem-solving, and the application of technology; understand how technological systems work with other systems; use mathematics knowledge and skills in solving problems; communicate effectively through reading, writing, listening and speaking; and work effectively with others.[39] PLTW aimed its programs for the top 80 percent of students. Students enrolled in the PLTW program were required to be enrolled in a college preparatory math sequence as well.[40] They were also required to take end-of-course examinations in all but the capstone course.[41] Several affiliated universities offered college credit for adequate end-of-course

[36] Jonathan M. Breiner, Shelly Sheats, Carla C. Johnson, and Catherine M. Koehler. (January 2012). "What Is STEM? A Discussion About Conceptions of STEM in Education and Partnerships." *School Science and Mathematics.* Volume 112, Issue 1, pages 3–11, http://onlinelibrary.wiley.com/doi/10.1111/j.1949-8594.2011.00109.x/epdf

[37] See www.sreb.org/high-schools-work

[38] Pam Newberry, T. Richard Grimsley, John Hansen, and Anne Spence. (2006). "Research of Project Lead the Way Curricula, Pedagogy, and Professional Development: Activities Regarding Increasing Engineering and Technological Literacy of K12 students in the PLTW Network." In Proceedings of the Annual Conference of the American Society for Engineering Education. Chicago, IL. <https://peer.asee.org/648>

[39] Ibid.

[40] Ibid.

[41] Ibid.

examination scores and cumulative averages.[42] When PLTW compared its students to those enrolled in the HSTW schools with similar career/technical fields, PLTW students out performed non-PLTW students. They completed more science and math classes and scored higher on NAEP tests.[43]

A longitudinal study reviewed by the National Center for Education Statistics looked at various characteristics of beginning postsecondary students that entered STEM fields between 1995 and 2001.[44] The percentage of men who entered STEM fields was higher than that of women (33 percent vs. 14 percent), especially in the fields of mathematics, engineering/engineering technologies, and computer/information sciences.[45] In the referenced study, it reported 15.1 male to 2.7 female entering the field of engineering.[46] The same study also reported that 20.8 and 27.8 left the engineering STEM field to a non-STEM field or left post-secondary schooling without a

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[42] Pam Newberry, T. Richard Grimsley, John Hansen, and Anne Spence. (2006). “Research of Project Lead the Way Curricula, Pedagogy, and Professional Development: Activities Regarding Increasing Engineering and Technological Literacy of K12 students in the PLTW Network.” In Proceedings of the Annual Conference of the American Society for Engineering Education. Chicago, IL. <https://peer.asee.org/648>

[43] Ibid.

[44] This study primarily uses longitudinal data from the 1995−96 Beginning Postsecondary Students Longitudinal Study (BPS:96/01). This survey began in 1995–96 with a nationally representative sample of approximately 12,000 first-time students who enrolled in postsecondary education in 1995–96. These students were interviewed again in 1998 and, for the last time, in 2001, about 6 years after their initial college entry. The longitudinal design of BPS permits examination of student entrance, persistence, and attainment in STEM fields over the period of time in which most students complete a bachelor’s degree. To examine students’ paths to STEM degrees, this study used a sample of about 9,000 BPS students who participated in the initial survey in 1996 and the two follow-up surveys in 1998 and 2001 and who reported a major (including “undeclared major”) in at least one of three data collections.

[45] Xianglei Chen. (July 2009). “Stats in Brief: Students Who Study Science, Technology, Engineering, and Mathematics (STEM) in Postsecondary Education.” U.S. Department of Education. National Center for Education Statistics. http://files.eric.ed.gov/fulltext/ED506035.pdf

[46] Ibid.

degree altogether.[47] Studies indicated that while young women were as competent as young men in the STEM disciplines, they often tended to believe that science and technology were not relevant to their future career goals or they did not find the learning contexts inviting.[48] For this reason, recruiting efforts of females to the field was increasing.

History and Demand for Career Academies

Focusing more precisely on future employer demand illuminated part of the challenge, but there was also a problem at the supply end of the equation. Increasingly, U.S. employers complained that young potential employees were not equipped with the skills they needed to succeed in the 21st Century workforce.[49] The Partnership for 21st Century Skills, whose members included such companies as Microsoft, Apple, Cisco, and Pearson, had been equally critical of what it sees as obsolete and outmoded approaches to education, and was calling for more focus on the development of such "21st century *(sic)* skills" as critical thinking, problem solving, creativity and communication.[50] This demand for prepared students specifically in the STEM fields led to the increase and overwhelming support of career academies. Educational institutions have been criticized for being focused too exclusively on a few narrow pathways to

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[47] Xianglei Chen. (July 2009). "Stats in Brief: Students Who Study Science, Technology, Engineering, and Mathematics (STEM) in Postsecondary Education." U.S. Department of Education. National Center for Education Statistics. http://files.eric.ed.gov/fulltext/ED506035.pdf

[48] Sean Brophy, Stacy Klein, Merrideth Portsmore, and Chris Rogers. (2008). "Advancing Engineering Education in P-12 Classrooms." *Journal of Engineering Education*, 97: p.369. doi:10.1002/j.2168-9830.2008.tb00985.x

[49] Pathways to Prosperity Project. (February 2011). "Meeting the Challenge of Preparing Young Americans for the 21st Century." Harvard University College of Education.

[50] Ibid.

success. A path that is richly diversified to align with the needs and interests of young people and better designed to meet the needs of a 21st Century economy.[51]

Several organizations emerged to bridge the career and skill gap that occurred in the educational system.[52] Growth in the number of academies accelerated since 1990, and reached about 7,000 in 2010.[53] Before 2004, accurate counts of career academies were available only from three organized networks. In Philadelphia, the nonprofit Philadelphia Academies, Inc. had supported career academies since 1969. After two nonprofit academies were established in 1981 in California, academies were then fully funded in 1985.[54] The nonprofit National Academy Foundation (NAF) sponsored academies since 1982, and in 2014-16 supported academies in forty different states.[55] The number of academies in these three networks together grew to about a hundred in 1990, expanded to more than 700 in 2000, and exceeded 1,000 in 2010.[56]

At inception, career academies were especially focused on addressing the needs of youth of urban populations with high-risk drop-out rates, but these academies had a much broader role in all types of institutions including high performing schools and non-

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[51] Pathways to Prosperity Project. (February 2011). "Meeting the Challenge of Preparing Young Americans for the 21st Century." Harvard University College of Education.

[52] Project Lead the Way (PLTW), National Academy Foundation (NAF), Ford Next Generation Learning, National Career Academy Coalition were among the organizations formed to establish STEM programs and resources to answer to the government STEM reform and prepare young adults for the 21st Century workforce.

[53] Pathways to Prosperity Project. (February 2011). "Meeting the Challenge of Preparing Young Americans for the 21st Century." Harvard University College of Education.

[54] David Stern, Charles Dayton, and Marilyn Raby. (October 2000). "Career Academies: Building Blocks for Reconstructing American High Schools." University of California at Berkeley.

[55] National Academy Foundation. www.naf.org

[56] David Stern, Charles Dayton, and Marilyn Raby. (October 2000). "Career Academies: Building Blocks for Reconstructing American High Schools." University of California at Berkeley.

traditional or specialty schools in 2014-16.[57] Career academies expanded to the country's highest performing school districts and schools of all types. Innovative career academies through programs like New York State's New Visions provided students with advanced opportunities.[58] In this program, Advanced Placement level high school seniors took their senior year courses at work sites such as hospitals, environmental centers, and law firms.[59]

Branching from these three organizations, the National Career Academy Coalition partnered with organizations pledging to invest in career education. One organization driven by the Ford automobile company encompassed the comprehensive system and package that schools implemented.[60] Career and interest-themed academies served as the Ford NGL practice model for transforming the secondary school experience.[61] As a strong advocate on behalf of academies, Ford Next Generation Learning (NGL) recognized that most skilled employment required a foundation of academic, Twenty-First Century, and technical knowledge and skills that must be mastered in high school, as well as additional education beyond high school. Ford believed that the most successful approach for high schools was one that infused

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[57] The Role of Career Academies in Education Improvement. (2009). Association for Career and Technical Education. <http://www.ncacinc.com/sites/default/files/media/research/ACTE%20Issue%20Brief%20Career_academies.pdf>

[58] Ibid.

[59] The Role of Career Academies in Education Improvement. (2009). Association for Career and Technical Education. http://www.ncacinc.com/sites/default/files/media/research/ACTE%20Issue%20Brief%20Career_academies.pdf

[60] Ford Next Generation Learning. (2017). <https://fordngl.com/about>

[61] Ibid.

the high expectations and academic rigor of college preparatory academic programs with the real-world relevance and rigor of Career and Technical Education (CTE).[62]

Similar to this approach, the National Academy Foundation (NAF) created a curriculum to market to secondary schools referenced in chapter one. NAF incorporated an industry-validated career-themed curriculum in multiple disciplines that incorporated current industry standards and practices, literacy strategies, and STEM integration.[63] This instructional strategy worked to provide students with a well-rounded skill set that went beyond academics and included the soft skills needed to succeed in college and the working world. NAF's approach to work-based learning was centered on a continuum of work-based learning experiences beginning with career awareness activities, progressing to career exploration activities, and culminating in career preparation activities, including internships.[64]

Industry certifications were the central component of the implementation of the Florida Career and Professional Education Act passed in 2007.[65] The purpose of the

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[62] Ford Next Generation Learning. (2017). <https://fordngl.com/about>

[63] National Academy Foundation (2015). www.naf.org

[64] Ibid.

[65] Refer to Florida State Statute Section 1003.4203 - Digital materials, CAPE Digital Tool certificates, and technical assistance; Section 1003.491 – Florida Career and Professional Education Act; Section 1003.492 – Industry-certified career education programs; Section 1003.493 – Career and professional academies and career-themed courses; Section 1003.4935 - Middle grades career and professional academy courses and career-themed courses; Section 1008.44 – CAPE Industry Certification Funding List and CAPE Postsecondary Industry Certification Funding List; and Section 1011.62(1)(o) – Calculation of additional full-time equivalent membership based on successful completion of a career-themed course pursuant to ss. 1003.491, 1003.492, and 1003.493, or courses with embedded CAPE industry certifications or CAPE Digital Tool certificates, and issuance of industry certification identified on the CAPE Industry Certification Funding List pursuant to rules adopted by the State Board of Education or CAPE Digital Tool certificates pursuant to s. 1003.4203. The Florida Statutes can be accessed at the following web link: http://leg.state.fl.us

Act was to provide a statewide planning partnership between the business and education communities in order to attract, expand, and retain targeted, high-value industry and to sustain a strong, knowledge-based economy.[66]

Cost Estimation and Funding

Grants were a large source of the funds that a school district used to generate funds to operate career and technical education, STEM programs, and purchase supplies. A total of 1,535 schools in 634 districts received federal Smaller Learning Community (SLC) grants from 2000 through 2007 according to the US Department of Education's Smaller Learning Communities Awards Database.[67]

The FDOE received federal funding from the U.S. Department of Education for Career and Technical Education (CTE) under the Carl D. Perkins Career and Technical Education Act of 2006[68] and for adult education (AE) and family literacy under the Adult Education and Family Literacy Act of 1998.[69] FDOE awarded sub-grants to eligible providers to administer local programs. FDOE monitored providers to ensure compliance with federal requirements, including Florida's approved state plans for CTE and adult education/family literacy.[70] Each state had procedures for reviewing and approving applications for sub-grants, providing technical assistance, evaluating

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[66] Florida Department of Education. (2015). Secondary Industry Certification. http://www.fldoe.org/academics/career-adult-edu/industry-certification/secondary.stml

[67] U.S. Department of Education. Programs: Smaller Learning Communities Program. <https://www2.ed.gov/programs/slcp/index.html>

[68] See https://www2.ed.gov/policy/sectech/leg/perkins/index.html

[69] See https://www2.ed.gov/policy/adulted/leg/legis.html?exp=0

[70] Career and Adult Education: Florida Department of Education. Quality Assurance and Compliance Onsite Monitoring Visit Report: (2015). <http://www.fldoe.org/core/fileparse.php/7526/urlt/1415Collier.pdf>

projects, and for performing other administrative responsibilities the state determined were necessary to ensure compliance with applicable statutes and regulations. The division was also required to oversee the performance of sub-grantees in the enforcement of all laws and rules.[71] FTE (Full-time Enrollment) state funding per student was spread out among the resources and course enrollment in each grade level.[72]

To outfit an Engineering lab, the start-up total cost for one high school lab with 20 student stations equipped for all five Engineering courses is approximately $95,500. The cost will be less if the school already has equipment and/or computers that meet PLTW specifications. The Introduction to Engineering course total cost is $40,465 with computers ($24,117), equipment ($8,943), supplies ($167), furniture ($5,420), software requirements ($1,251) and consumables ($567) included in the total.[73]

Summary

Organizations such as National Academy Foundation (NAF) emerged to bridge the career and skill gap occurring in the educational system. The focus on STEM (Science, Technology, Engineering, and Math) integration in school programs also utilized programs such as Project Lead the Way (PLTW) to increase innovative thinking, career-centered learning, and industry-based education. The literature suggested the implementation of career-themed academies coupled with a STEM focus within schools, attributed to positive gains to mold career-ready students. The impact of NAF

[71] Sections 1001.03(8) and 1008.32, Florida Statutes

[72] See http://www.fldoe.org/finance/fl-edu-finance-program-fefp/fte-info/

[73] "High Schools that Work Presents a Pre-Engineering Program of Study." (2016). National Alliance for Pre-Engineering and Project Lead the Way. Southern Regional Education Board. <https://www.sreb.org/sites/main/files/file-attachments/01v56_engineering_web1.pdf>

enrollment on high-stakes testing had yet to be isolated as the literature focused on career-ready indicators. Recruitment of students to connect traditional education subjects to an applicable skill remained an initiative in public, charter, and academy schools alike.

CHAPTER 3
METHODS

For the research, eight high schools were selected in a Southwest Florida district. Since the results of End of Course test scores for NAF enrollees were compared against those for non-enrollees, there were two sets of data that were collected: a list of student scores on End of Course tests and a list of students who were participating in NAF enrolled academies at the time those scores were achieved. In order to compare the results by gender, data were collected. Two years of NAF enrollment and EOC Geometry scores (2014-15 and 2015-16) were collected and analyzed separately due to the changing scale scores implemented by the Florida Department of Education Office of Assessments. Two years of data were used to gather a trend of results and provide additional reliability of findings over time. Since numerous NAF academies were implemented in each school and the Engineering Academy was consistent across all schools, engineering was selected. The engineering course, Introduction to Engineering, was the corresponding course to the students taking the Geometry EOC.

Research Design

The 2014-2015 and 2015-2016 End of Course test scores were utilized for the data collection. To ensure appropriate and meaningful data, only scores from the academic area that have served as exit standards for high school students (Geometry) were utilized (Table 3-1).

After determining what data were needed and the schools that would be involved, the actual data collection was compiled through the district Data-warehouse site through written approval and permission for research.[1] Once the necessary data

[1] See Appendix A.

were collected, students were anonymously compiled into a master spreadsheet with columns enrolled Engineering program NAF student (Y or N), test score, and the gender of each student. For the analysis of these data, the information was uploaded into SPSS for the statistical analysis. The population selection included all students district-wide who took the Geometry EOC in the 2014-15 and 2015-16 school years. The Geometry exam was chosen due to the course enrollments coinciding with NAF membership across the school district. Also, two years of data were selected to provide a two-year scope of performance scores since the NAF programs were newly implemented in 2014-15 and were increasing enrollment in the 2015-16 school year. This increased the sample size of the NAF enrolled students compared with the Geometry EOC performance.

Geometry score ranges and levels for 2014-15 were shifted to new score ranges per level in 2015-16. Comparison of the two score sets for each year were calculated where level 3 still remained the proficient level; however these data were not combined since the test score ranges and corresponding levels changed. Table 3-2 and Table 3-3 show these score ranges for 2014-15 while Table 3-4 and 3-5 show the ranges for 2015-16.

To examine the research question, a two-way analysis of variance (ANOVA) was conducted to assess if mean differences exist. The two-way ANOVA was an appropriate statistical analysis when the purpose of research was to compare two or more discrete groups on a continuous dependent variable that were measured more than once. For this research, the continuous dependent variables were the EOC Geometry test; the independent variable has the following groups (NAF Engineering

Enrollment vs. Non-NAF Engineering Enrollment and Female NAF Engineering vs. Male NAF Engineering vs. Female Non-NAF Engineering vs. Male Non-NAF Engineering).

Data Analysis Plan

The ANOVA used the F test, which research reflects the overall comparison on whether group means differ. If the obtained F were larger than the critical F, the null hypothesis was rejected. The results of the two-way ANOVA presented findings for the main effect and evaluated the overall differences by time (within-subjects) and also separately by group (between-subjects). The dependent variable should be approximately normally distributed for each level of the independent variable. For the purpose of the research, a level of significance or 0.05 was selected in order to determine whether to accept or reject the null hypotheses as well.[2]

The P value, or calculated probability, was the probability of finding the observed, or more extreme, results when the null hypothesis (H_0) of a study question was true – the definition of 'extreme' depends on how the hypothesis was being tested. The null hypothesis was a hypothesis of "no difference" e.g. no difference between EOC test scores and groups (NAF, Non-NAF, male or female). The term significance level (alpha) was used to refer to a pre-chosen probability and the term "P value" was used to indicate a probability calculated following the study.

The alternative hypothesis (H_a) was the opposite of the null hypothesis; which was the hypothesis set out to investigate. For the purpose of this study, H_a: EOC Geometry scores differ by (independent variable Group 1 vs. Group 2) NAF enrollment vs. Non-NAF enrollment; and H_a: EOC Geometry scores differ by gender (independent

[2] Statistics Solutions. (2016). Data analysis plan: One-Within, One-Between ANOVA [WWW Document]. Retrieved from http://www.statisticssolutions.com/data-analysis-plan-one-within-one-between-anova/

variable: group 1 vs. group 2 including NAF enrollment analysis by gender). This test was run using a two-way ANOVA to calculate mean, standard deviation, and significance.

If the P value were less than the chosen significance level, then the null hypothesis would be rejected. For this study, the significance level at which the H_0 would be rejected was set at .05 or less than 5 percent or less than 5 five in one hundred chance of being wrong.

Research Questions

1. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2014-15?

   Ho: EOC Geometry scores did not differ by group NAF enrollment vs. Non-NAF enrollment (Independent variable Group 1 vs. Group 2) in 2014-15.

   Ha: EOC Geometry scores differed by (independent variable Group 1 vs. Group 2) NAF enrollment vs. Non-NAF enrollment in 2014-15.

2. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2014-15?

   Ho: EOC Geometry scores did not differ by gender when enrolled in NAF Engineering or not enrolled in NAF Engineering. (independent variable: group 1 vs. group 2) in 2014-15.

   Ha: EOC Geometry scores differed by gender (independent variable: group 1 vs. group 2) in 2014-15.

3. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2015-16?

   Ho: EOC Geometry scores did not differ by group NAF enrollment vs. Non-NAF enrollment (Independent variable Group 1 vs. Group 2) in 2015-16.

   Ha: EOC Geometry scores differed by (independent variable Group 1 vs. Group 2) NAF enrollment vs. Non-NAF enrollment in 2015-16.

4. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2015-16?

Ho: EOC Geometry scores did not differ by gender when enrolled in NAF Engineering or not enrolled in NAF Engineering (independent variable: group 1 vs. group 2) in 2015-16.

Ha: EOC Geometry scores differed by gender (independent variable: group 1 vs. group 2) in 2015-16.

5. Was NAF Engineering enrollment significant in the Geometry EOC score results and did this significance demonstrate cost-effectiveness of the NAF Engineering program?

Ho: NAF Engineering enrollment was not significant on Geometry EOC score results thus not demonstrating cost-effectiveness of the program.

Ha: NAF Engineering enrollment was significant on Geometry EOC score results thus demonstrating cost-effectiveness of the program.

Summary

The research methods included population selection, research design, data analysis plan, and outline of research questions including hypotheses. Population included 9th and 10th grade students in the selected school district who were enrolled in Geometry or Geometry Honors courses in the 2014-15 and 2015-16 school years. The selection included 2,513 students (1,312 males and 1,286 females) in 2014-15 (Table 7) and 2,264 students (1,288 males and 1,185 females) in 2015-16 (Table 12). Also identified were NAF Engineering enrolled students from the population selection. In 2014-15, there were eighty-five NAF engineering students (seventy-two males and thirteen females) concurrently enrolled in Geometry courses. In 2015-16, there were 210 NAF engineering students (169 males and 41 females) concurrently enrolled in Geometry courses. Data were gathered with no names present and at no time were students identified by any means. All data were centrally compiled by the district Career and Technical office and collected by the researcher. The research questions guided the direction of the study to determine any significance difference in performance on the Geometry EOC in the subgroups.

Table 3-1. FSA EOC Corresponding Course List 2014-15 and 2015-16

Geometry EOC	Course
	Geometry – 1206310 Geometry Honors – 1206320 IB Middle Years Program Geometry Honors – 1206810 Pre-AICE Mathematics 2 – 1209820

Table 3-2. Geometry Score Ranges and Level 2014-15[3]

Level 1	Level 2	Level 3 (Passing)	Level 4	Level 5
325-369	370-395	396-417	418-433	434-475

Table 3-3. 2014-15 Florida End-of-Course Assessments Achievement Level Policy Definitions[4]

Level	Description
Level 5	Students at this level demonstrate mastery of the most challenging content of the Next Generation Sunshine State Standards.
Level 4	Students at this level demonstrate an above satisfactory level of success with the challenging content of the Next Generation Sunshine State Standards.
Level 3	Students at this level demonstrate a satisfactory level of success with the challenging content of the Next Generation Sunshine State Standards.
Level 2	Students at this level demonstrate a below satisfactory level of success with the challenging content of the Next Generation Sunshine State Standards.
Level 1	Students at this level demonstrate an inadequate level of success with the challenging content of the Next Generation Sunshine State Standards.

[3] FCAT 2.0 and Florida EOC Assessments Achievement Levels (February 2014). Florida Department of Education/Office of Assessment. <http://www.fldoe.org/core/fileparse.php/3/urlt/achlevel.pdf>

[4] Ibid.

Table 3-4. 2015-16 Florida End-of-Course Assessments Achievement Level Policy Definitions[5]

Level 1	Level 2	Level 3	Level 4	Level 5
Inadequate: Highly likely to need substantial support for the next grade	Below Satisfactory: Likely to need substantial support for the next grade	Satisfactory: May need additional support for the next grade	Proficient: Likely to excel in the next grade	Mastery: Highly likely to excel in the next grade

Table 3-5. 2015-16 FSA EOC Scale Scores for Each Achievement Level[6]

Assessment	Level 1	Level 2	Level 3	Level 4	Level 5
EOC Scale Scores	425-485	486-498	499-520	521-532	533-575

[5] Florida Standards Assessments: 2015–16 FSA Algebra 1, Algebra 2, and Geometry End-of-Course Assessments Fact Sheet. (January 2016). Bureau of K-12 Student Assessment. <http://www.fldoe.org/core/fileparse.php/5663/urlt/FSAEOC1516.pdf>

[6] Ibid.

CHAPTER 4
PRESENTATION OF RESULTS

The results of the EOC Geometry performance with NAF vs. Non-NAF enrollment and Gender correlations were outlined. As presented in chapter one, the research question addressed was: 1. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2014-15?; 2. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2014-15?; 3. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2015-16?; 4. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2015-16?; and 5. Was NAF Engineering enrollment significant in the Geometry EOC score results and did this significance demonstrate cost-effectiveness of the NAF Engineering program? This chapter presented the results derived by calculating the variance of Geometry EOC performance by NAF, non-NAF, and male, female subgroups by using ANOVA as presented in the methodology in chapter three. The results were presented by school year. Performance results from the 2014-2015 school year were presented first, followed by the results from the 2015-2016 school year (Tables 3-3 and 3-4).

Variance of Results 2014-15

A two-way ANOVA was conducted that examined the effect of gender and NAF enrollment on EOC Geometry assessment performance for 2014-15. The descriptive statistics of NAF and non-NAF students are listed (Table 4-1) and NAF/Non-NAF by gender (Table 4-2).

There was a not a significant interaction between the effects of gender and NAF enrollment on EOC Geometry performance ($p=.558$), but there was significant difference in the mean significance ($p=.000$) on EOC Geometry scores by NAF enrollment. $F(1, 2594) = .343$; with $N=2598$ (Table 4-3).

The null hypothesis was accepted that EOC Geometry scores did not differ by gender when enrolled in NAF Engineering or not enrolled in NAF Engineering (independent variable: group 1 vs. group 2) in 2014-15 (Table 4-4).

The 2014-15 mean scores of NAF (N=85) versus non-NAF (N= 2513) were 428.56 (std. dev. 18.333) and 410.78 (23.806) respectively (Table 4-5).

The estimated marginal means of scale for the 2014-15 Geometry scores for NAF and non-NAF students were illustrated. The graph demonstrates the disparity between the two groups' performance (Figure 4-1).

The null hypothesis for the second research question was rejected that EOC Geometry scores did not differ by group NAF enrollment vs. Non-NAF enrollment (Independent variable Group 1 vs. Group 2) in 2014-15 as outlined in Table 4-6.

Variance of Results 2015-16

A two-way ANOVA was conducted that examined the effect of gender and NAF enrollment on EOC Geometry assessment performance for 2015-16. There was not a significant interaction between the effects of gender and NAF enrollment on EOC Geometry performance ($p=.166$), but there was significant difference in the mean significance demonstrated by $p < .05$ on EOC Geometry scores by NAF enrollment. $F(1, 2469) = 1.915$; with $N=2474$ (Table 4-7).

The third research question's null hypothesis was rejected that EOC Geometry scores did not differ by group NAF enrollment vs. Non-NAF enrollment (Independent variable Group 1 vs. Group 2) in 2015-16. The estimated marginal means of scale for the 2015-16 Geometry scores for NAF and non-NAF students were illustrated. The graph demonstrated the disparity between the two groups' performance (Figure 4-2).

The 2015-16 mean scores of NAF (N=210) versus non-NAF (N= 2264) were 526.55 (std. dev. 18.756) and 503.21 (24.190) respectively listed in Tables 4-8 and 4-9. Although no significant difference was found in gender and NAF enrollment in 2015-16, NAF enrollment alone demonstrated significance over non-NAF students ($p < .05$) on the Geometry EOC exam. $F(1, 2469) = 106.510$ as indicated in Table 4-10.

The fourth research question's null hypothesis was accepted that EOC Geometry scores did not differ by gender when enrolled in NAF Engineering or not enrolled in NAF Engineering (independent variable: group 1 vs. group 2) in 2015-16.

The fifth research question's null hypothesis was rejected that NAF Engineering enrollment was significant on Geometry EOC score results thus demonstrating cost-effectiveness of the program.

Limitations in Results

The two years of Geometry EOC scores were scaled differently per changes by the Florida Department of Education Office of Assessment with 396 as a passing score in 2014-15 and 499 as a passing score in 2015-2016 with the levels of proficiency levels also adjusted. For this reason, this study did not compare mean scores between the two years but instead analyzed the standard deviation between subgroups and significance of NAF/non-NAF enrollment and gender on EOC Geometry performance.

As indicated in Chapter Two, the 2015-16 Geometry test underwent significant changes in scoring and the levels that indicated performance proficiency. In 2014-15, the scores ranged from 325 to 475. In 2015-16, the state migrated to the FSA platform for the Geometry EOC exam that changed the scoring ranges and matching proficiency levels. This is considered a limitation as an ideal comparison would not exist since the scales and exams are different.

In 2014-15, thirteen females and seventy-two males were NAF Engineering students who took the Geometry EOC in 2014-15. In 2015-2016, 41 females and 169 males were NAF Engineering students who took the Geometry EOC in 2015-16. Six of the eight high schools in this study were in the second or third full year of NAF Engineering implementation that demonstrated increasing enrollment who took the Geometry exam from 2014-15 to 2015-16 school year.

In 2014-15, students who were enrolled in the NAF engineering program scored a mean score of 428 (males) and 431.69 (females) that equated to a level 4 proficiency. Students not enrolled in the engineering program scored means of 410.50 (females) and 411.07 (males) that was a level 3 proficiency according to Florida State assessment performance scales as indicated in Table 4-6.

In 2015-16, students who were enrolled in the NAF engineering program scored a mean score of 527.45 (males) and 522.85 (females) that equated to Level 4 proficiency. Students not enrolled in the NAF engineering program scored a mean of 502.54 (males) and 503.83 (females) that was Level 3 proficiency according to the scales. The 2015-16 estimated marginal means for gender and NAF and non-NAF performance were indicated in Tables 4-11 and 4-12.

While gender did not show significant differences in the marginal means, NAF enrollment yielded a higher mean Geometry EOC score among males and females in the study. Limitations in the study were that the scaled scores per the two years were scaled differently not creating a scenario of comparison and that NAF enrollment might attract a higher-performing student in the recruitment process.

Cost-Effectiveness Analysis

Based on the performance and higher mean test scores in the two years reported (2014-15 and 2015-16 school years), the expenditures could be justified that National Academy Foundation Engineering membership may increase scores on the Geometry EOC exam. This demonstrated that there was some level of significance on EOC Geometry exam when enrolled in the NAF Engineering program to validate the minimal cost per student and Carl D. Perkins grant illustrated in this analysis.

The compilation of grants, FTE dollars, technology budget, and budgetary items in human capital for professional development of the academy were attributed as dollars receiving some return on investment. Specifically, the supply and materials cost per twenty Introductory of Engineering enrolled students were $929.73.[1] In 2014-15, there were eighty-five students enrolled in the Introductory to Engineering course in the selected school district yielding the cost per student at $46.49 and a total supply and materials cost of $3,951.65. In 2015-16, there were 210 students enrolled in the Introductory to Engineering course yielding the cost per student at $46.49 and a total supply and material cost of $9,762.90.

[1] Referencing the CTE workbook of supply costs for 2014-15 and 2015-16. (District name removed for anonymity).

Training for the Project Lead the Way (PLTW) Engineering Pathways was an estimated $4,500 to $5,000 per teacher depending on location of the training.[2] In 2014-15, ten teachers in the district were trained and in 2015-16, an additional three teachers were trained in 2015-16 in the Engineering Pathways workshop that was used for the Introduction to Engineering NAF course. Depending on the location, the amount spent in 2014-15 and 2015-16 totaled $58,500 to $65,000. This equated to an expense of $198.31 to $220.34 cost per student enrolled (295) in the program over a two-year period.

In 2014-15, grants totaling $435,051.00 for secondary Career and Technical education programs were received. Carl D. Perkins grant money (Perkins Vocational and Technical Secondary grant $410,355)[3] was also allocated and during a review of the district via a state quality assurance review, purchase orders, local grants, and technology purchases with grant money were tagged. The district furnished a five-year information technology plan that included a specialized plan for equipment with a $1,000 threshold for equipment specifically identified. All equipment purchased with grant funds were tagged and were located during the review.[4] In 2015-16, the Carl D. Perkins grant funded Career and Technical education in the allocated amount of

[2] Referencing the Project Lead the Way (PLTW) Teacher Training Excel spreadsheet outlined in the Appendix. Also, the cost was $4,700-$5,000 depending on the location of the training but this was not specified by the district.

[3] District Budget Book. Perkins Vocational and Technical Secondary Grant. (2014-15). Project no. 154206

[4] Career and Adult Education: Florida Department of Education. Quality Assurance and Compliance Onsite Monitoring Visit Report: (2015).

$423,887 to the school district, a 2013-14 roll-over of $24,156 totaling $448,043 for the selected school district.[5]

With the allocated funds, resources such as supplies recommended for the Engineering course by Project Lead the Way and NAF Engineering guidelines were purchased for each school. Technology needs were generated per the engineering course guidelines and were shared through the district technology department as many computers and resources were allocated from those resources and funds.[6]

The analysis of funding and spending in relation to performance specifically on the Geometry EOC was important to validate the program on some level. Although many variables exist to determine cost-effectiveness, one variable of NAF Engineering enrollment positively impacted Geometry test performance that can justify expenses to some degree in 2014-15 and 2015-16. For the two-year study, the supply cost per student was $46.49 and the teacher training cost was estimated at $198.31 to $220.34 per student, totaling the cost per student of supplies plus teacher training to $244.80 to $266.83 per student. The increased Geometry EOC scores per this enrollment coupled with the expense per student showed that the program was a good investment based on these factors.

Table 4-1. 2014-15 Geometry EOC scores of NAF/Non-NAF Students Descriptive Statistics

Dependent Variable	Mean	Std. Deviation	N
Non-NAF	410.78	23.806	2513
NAF	428.56	18.333	85
Total	411.36	23.855	2598

[5] Carl D. Perkins Career and Technical Education Act of 2006. (2015-16). http://www.fldoe.org/core/fileparse.php/13147/urlt/2015-16-Secondary-Roll-Forward.pdf

[6] Career and Technical Education Director. (2015). Career and Technical Education Department. District School of Study. (Name and school district removed for anonymity).

Table 4-2. 2014-15 Geometry EOC scores of NAF/Non-NAF Students by Gender Descriptive Statistics

Dependent Variable	Gender M=1, F=0	Mean	Std. Deviation	N
Non-NAF	Female	410.50	23.745	1273
	Male	411.07	23.874	1240
	Total	410.78	23.806	2513
NAF	Female	431.69	22.537	13
	Male	428.00	17.598	72
	Total	428.56	18.333	85
Total	Female	410.72	23.820	1286
	Male	412.00	23.882	1312
	Total	411.36	23.855	2598

Table 4-3. Univariate Analysis of Variance - Tests of Between-Subjects Effects 2014-15 Geometry EOC vs. NAF vs. Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	26318.554[a]	3	8772.851	15.678	.000
Intercept	30590141.360	1	30590141.360	54666.902	.000
Gender	108.800	1	108.800	.194	.659
NAF	15726.235	1	15726.235	28.104	.000
GENDER*NAF	192.165	1	192.165	.343	.558
Error	1451533.253	2594	559.573		
Total	441113389.000	2598			
Corrected Total	1477851.808	2597			

a. R Squared = .018 (Adjusted R Squared = .017

Table 4-4. 2014-15 Estimated Marginal Means: Gender

Scale Gender M=1 F=0	Mean	Std. Error	95% Confidence Lower Bound	Interval Upper Bound
Female	421.109	3.297	414.643	427.574
Male	419.523	1.434	416.712	422.335

Table 4-5. 2014-15 Estimated Marginal Means: NAF

Scale NAF	Mean	Std. Error	95% Confidence Lower Bound	Interval Upper Bound
Non-NAF	410.786	.472	409.861	411.711
NAF	429.846	3.564	422.857	436.835

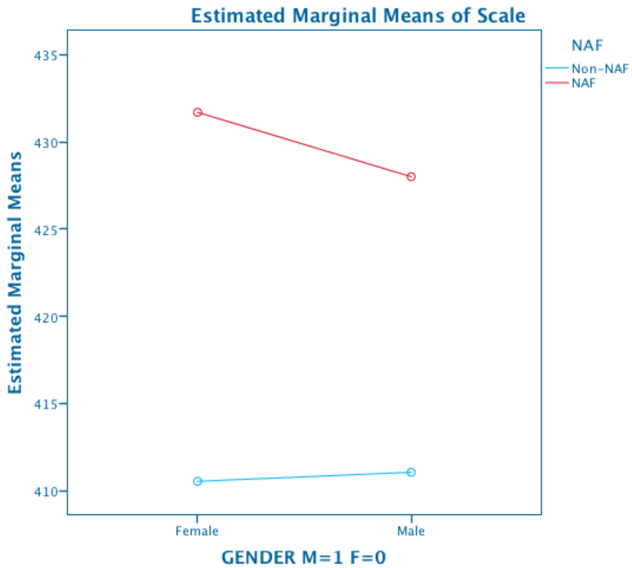

Figure 4-1. 2014-15 Estimated Marginal Means of Scale Graph Comparison

Table 4-6. 2014-15 Estimated Marginal Means: Gender and NAF

Scale Gender M=1 F=0	NAF	Mean	Std. Error	95% Confidence Lower Bound	Interval Upper Bound
Female	Non-NAF	410.525	.663	409.225	411.826
	NAF	431.692	6.561	418.827	444.557
Male	Non-NAF	411.047	.671	409.730	412.363
	NAF	428.000	2.788	422.533	433.467

Table 4-7. Univariate Analysis of Variance - Tests of Between-Subjects Effects 2015-16 Geometry EOC vs. NAF vs. Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	107773.717[a]	4	26943.429	47.699	.000
Intercept	4037059.084	1	4037059.084	7147.032	.000
Gender	1768.972	2	884.486	1.566	.209
NAF	60163.018	1	60163.018	106.510	.000
GENDER*NAF	1081.979	1	1081.979	1.915	.166
Error	1394634.700	2469	564.858		
Total	632915110.000	2474			
Corrected Total	1502408.417	2473			

a. R Squared = .072 (Adjusted R Squared = .070

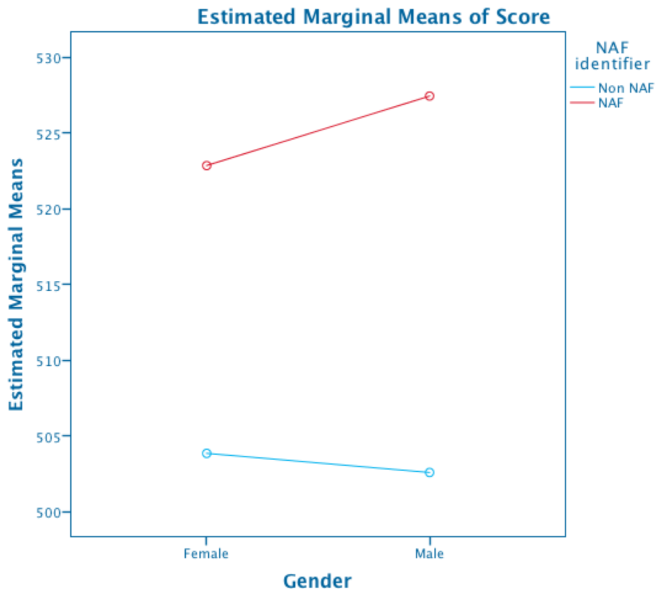

Figure 4-2. 2015-16 Estimated Marginal Means of Scale Graph Comparison Gender * NAF identifier

Table 4-8. Descriptive Statistics: 2015-16 Mean Geometry EOC Scores for NAF/Non-NAF and Gender Comparisons

Gender M=1 F=0	NAF Identifier	Mean	Std. Deviation	N
Female	Non NAF	503.83	23.589	1144
	NAF	522.85	23.205	41
	Total	504.49	23.789	1185
Male	Non NAF	502.54	24.767	1119
	NAF	527.45	17.778	169
	Total	505.81	25.395	1288
Total	Non NAF	503.21	24.190	2264
	NAF	526.55	18.756	210
	Total	505.19	24.648	2474

Table 4-9. 2015-16 Estimated Marginal Means: NAF

Scale			95% Confidence	Interval
NAF	Mean	Std. Error	Lower Bound	Upper Bound
Non-NAF	515.792	7.929	500.243	531.340
NAF	525.152	2.069	521.095	529.208

Table 4-10. Univariate Analysis of Variance - Tests of Between-Subjects Effects 2015-16 Geometry EOC vs. NAF vs. Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	107773.717[a]	4	26943.429	47.699	.000
Intercept	4037059.084	1	4037059.084	7147.032	.000
Gender	1768.972	2	884.486	1.566	.209
NAF	60163.018	1	60163.018	106.510	.000
GENDER*NAF	1081.979	1	1081.979	1.915	.166
Error	1394634.700	2469	564.858		
Total	632915110.000	2474			
Corrected Total	1502408.417	2473			

a. R Squared = .072 (Adjusted R Squared = .070

Table 4-11. 2015-16 Estimated Marginal Means: Gender

Scale Gender	Mean	Std. Error	95% Confidence Lower Bound	Interval Upper Bound
Female	513.344	1.889	509.640	517.048
Male	514.995	.981	513.072	516.918

Table 4-12. 2015-16 Estimated Marginal Means: Gender and NAF

Scale Gender M=1 F=0	NAF	Mean	Std. Error	95% Confidence Lower Bound	Interval Upper Bound
Female	Non-NAF	503.835	.703	502.457	505.213
	NAF	522.854	3.712	515.575	530.132
Male	Non-NAF	502.540	.710	501.147	503.933
	NAF	527.450	1.828	523.865	531.035

CHAPTER 5
CONCLUSIONS AND IMPLICATIONS

The demands of high-stake tests not only affected what is and what is not taught within courses, it is valid to recognize the importance of career-readiness to students, parents and industries. The greater need for career-ready students in the STEM fields led to the increased funding and focus on Career and Technical Education (CTE). Geometry End-of-Course test minimum scores that were required for graduation in 2014-15 and 2015-16 also fueled the infiltration of applicable real-world learning experiences with the anticipated increase of pass rate and score averages with enrollment in programs such as the National Academy Foundation Engineering program.

This study allowed the researcher to examine the following research questions:

1. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2014-15?
2. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2014-15?
3. Did EOC Geometry scores differ by Enrollment in a NAF Engineering program or non-Enrollment in a NAF Engineering program in 2015-16?
4. Did EOC Geometry scores differ by Gender when enrolled in a NAF Engineering program or not Enrolled in a NAF Engineering program (independent variable: Group 1 vs. Group 2) in 2015-16?
5. Was NAF Engineering enrollment significant in the Geometry EOC score results and did this significance demonstrate cost-effectiveness of the NAF Engineering program?

Significance of the Study

The significance of this study was two-fold. First, the study determined the performance of National Academy Foundation Engineering students on the Geometry

End-of-Course assessment compared to Non-NAF Engineering students. The study also analyzed the performance of males and females in comparison to each other while considering NAF enrollment. The study was conducted over a two-year period to gather a significant amount of data to identify any trends. Second, the study was conducted to identify cost-effectiveness of the NAF program based on this performance. Supply costs as well as teacher training expenses were utilized to gather a per-cost student amount that would be spent above and beyond the FTE allowance. The two-year study showed that NAF Engineering enrollment played a significant positive impact on Geometry EOC test score averages. The NAF Engineering program was also determined to be cost-effective based on the increased test score averages and the relatively small cost per student allocated using the Carl D. Perkins grants and FTE expenditures.

This study supports the work of Bottoms and Anthony, Bottoms and Uhn, Rethwisch, Haynes ,Starobin, Laanan and Schenk as well as the Texas study by Van Overschelde outlined in Chapter 2. The studies indicated higher performing levels on exams achieved by PLTW enrolled students.

Implications of the Study

The major implications of this study were that it illustrated how performance on the Geometry EOC was impacted by NAF Engineering enrollment over a two-year period. Gender performance also was determined to provide an analysis of whether NAF enrollment showed any impact. Using a two-way analysis of variance, ANOVA, the similarities and differences within the groups were compared within the NAF membership itself, and then compared across all groups in the ensuing explanations.

The implications of the study allow for justification and purpose for the NAF engineering program especially due to the increased test scores that could be attributed to real-world application of math concepts and critical thinking skills utilized in the course. Validating cost of the program illustrated the purposeful spending or dollar allocation of the grants as well as the local and state expenses.

Limitations and Assumptions

The potential for human error in the data collection due to the lack of an efficient way to collect and mark data indicating NAF students and gender identifiers was present. No current means existed that would allow test data to easily be separated by NAF enrollment status coupled with gender. This information may be uploaded into the Data-warehouse system for greater accuracy and comparison purposes. NAF enrollment was housed in a separate program provided by NAF software and exported to an EXCEL spreadsheet. The district's data program may streamline this process and make it efficient to cross-reference for future studies.

The Florida Education Finance Program (FEFP) determined funding including programs, instructional materials at $7,742 per student.[1] Local officials must make the complex and difficult decisions to fund programs from this allocated amount. The amount of FTE dollars used for NAF and non-NAF students was not used to determine cost-effectiveness since these dollars would be allocated elsewhere if the NAF Engineering program did not exist. Also, teacher salary was not included as the

[1] See Appendix B.

teachers employed to teach the Engineering program would be teaching another discipline if the NAF program did not exist.

The supplemental figures located in Appendix B demonstrate the monies geared toward the instructional programs, resources, and personnel requirements to operate;[2] however, this figure is not included to determine cost-effectiveness of the NAF Engineering program since these dollars would be allocated to other areas if the engineering program did not exist. The district of study budget expense allocations that 63.6 percent of the budget is allocated for direct instruction; technology services of .7 percent and instructional support at 8.2 percent. These dollars are also not specific to any extra costs needed to operate the NAF Engineering program. Local officials are tasked with allocating these dollars to fund programs.

Conclusions

NAF's educational design included four essential elements of practice: academy development & structure, curriculum & instruction, advisory board, and work-based learning. These elements built on each other to engage students, support school and district priorities, and give businesses the opportunity to connect with students and offer internships while a member of the program.[3] Students who immersed themselves in career and technical education had a connection to the real-world which may validate traditional math studies. As reported in this study, the positive impact that NAF engineering enrollment may play on performance of the Geometry EOC could be a precursor to market the measurable impact to students. Specifically, the students

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[2] Ibid.
[3] National Academy Foundation (NAF). <www.naf.org>

enrolled in NAF (as reported in Chapter four) scored at means one level of proficiency higher than non-NAF engineering students (Level 4 to Level 3 in comparison). Immersion into STEM focused curricula was tied to critical thinking, decision-making, and connection to real-world applicable learning. Basic concepts learned in this traditional Geometry course then applied to the engineering courses material may conclude higher performance on standardized tests. This may be a broad statement since there are multiple variables affecting student performance: attendance, parental support, learning abilities, intelligence, socio-economic limitations, outside resources or factors to name a few. Although gender did not have major influence on performance, the enrollment of females into engineering courses from 2014-15 to 2015-16 showed growing interest in the program.

If programs within public schools were funded to provide students career-ready skills, students may gravitate to those programs rather than seeking other alternatives. The study approached a static model employing a conservative measure of cost-effectiveness of the Introduction to Engineering program. Other programs may have existed that would demonstrate the benefit to students' test scores including other NAF and PLTW programs. Grant money received may also have been allocated elsewhere if the NAF Engineering program did not exist. Cost of these other programs were not compared in this study to determine the measure of effectiveness; however, the cost of the Intro to Engineering program was analyzed for effectiveness based on Geometry exam performance to gain insight on expenditures specific to that course. The funds and required program analysis reviewed by the state and local board ensure parents that there were quantitative benefits over and above the career-ready skills they seek for their children.

It is suggested that research in the area for future consideration should explore the possibility of an association between math and science achievement level and a student's desire to continue a college or career path in engineering or similar math and science related paths and the correlation between their other areas of achievement. In addition, STEM certification may need to be evaluated as this certification may yield higher performance. Further investigation into the growth of students over time may also yield insight into the strength of the NAF and PLTW programs over time for cohort students. Also, further research needs to be evaluated on the cost-effectiveness of additional NAF engineering courses or other NAF academic tract programs and benefits that may serve the students other than math and science test scores.

APPENDIX A
RESEARCH REQUEST

[redacted] [redacted]

July 13, 2015

Re: Research Request **134F01**

Dear Ms. Stalcup:

The above referenced request has been approved by the [redacted] Public Schools Research and Data Committee. It is now your obligation to conduct the study as outlined in the proposal and the [redacted] *School District Guidelines for Conducting Research*.

Your approval is also subject to the following guidelines as designated by the committee:

(a) Information is collected anonymously, and no personally identifiable information is obtained from or reported on any individual student, person, group, or organization.
If your research involves the collection of data from students, you must provide details of your study, (survey questions to be asked, etc.) and get signed permission from their parents/guardians.
(b) If the district is to be identified in any manner in the final report of an approved study, prior permission must be secured.
(c) The cooperating organization or individual will furnish a copy of the final results to the district.
(d) All personnel involved (staff, teachers, administrators, etc.) know it is voluntary to participate and identity information is kept confidential.
(e) Research conducted on accepted proposals must be actively underway within one (1) year of the date of acceptance. Researchers must request an extension for approved research proposals that are not initiated and actively underway by this time.
(f) Approval means the researcher may collect data as specified in the original proposal.
This notification is not approval to provide data, promise of services, nor is it permission to use district data. Should the researcher pursue data beyond the parameters of the research proposal, all access to district resources will be denied to the researcher and any organization he/she presently represents.
(g) Approval does not include any services from the district including access to district databases (unless it is public information available through the district's public information office.)
(h) Personnel from the Department of Assessments and Data Management will not provide research services.
(i) The researcher must notify the committee about any changes made to the original proposal.
The committee reserves the right to rescind its approval if the modifications do not satisfy any of the conditions detailed above.

Please contact the Office of Assessments and Data Management should you have any questions or concerns.
Respectfully,

[redacted]
Coordinator
Research Committee

[redacted]

APPENDIX B
SUPPLEMENTAL FIGURES

FTE Students	x	Program Cost Factors	=	**Weighted FTE Students**	x	Base Student Allocation (BSA)	x	District Cost Differential (DCD)	=	**Base Funding**	+	DJJ Supplements	+
Declining Enrollment Supplement	+	Sparsity Supplement	+	State-Funded Discretionary Contribution	+	0.748 Mills Discretionary Compression	+	Safe Schools	+	Reading Program	+	Supplemental Academic Instruction	+
ESE Guaranteed Allocation	+	Instructional Materials	+	Teachers Classroom Supply Assistance	+	Student Transportation	+	Virtual Education Contribution	+	Digital Classrooms Allocation	=	**Gross State and Local FEFP Dollars**	-
Required Local Effort	=	**Gross State FEFP**	+	Adjustments	=	**Net State FEFP Allocation**	+	Categorical Program Funds	=	**Total State Finance Program**			

Figure B-1. Florida Education Finance Program (FEFP) Equation[4]

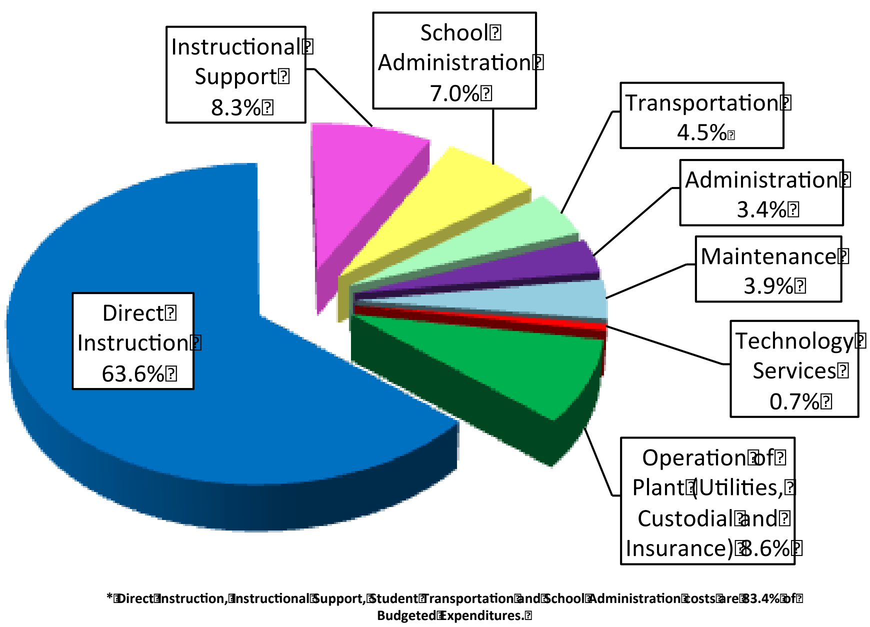

Figure B-2. 2015 District of Study Budget Expense Allocations[5]

[4] Board Implementation PowerPoint. (2015) District Study Report. The school district name is removed for anonymity.

[5] Ibid.

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BIOGRAPHICAL SKETCH

Kimberly Ann Stalcup was born in Somers Point, New Jersey. She moved to Florida with her family in 1983 and graduated from Barron Collier High School in 1995. She earned her B.A. in history and specialized in secondary education in 2000 from the University of Florida. She earned her M.Ed. in educational leadership in 2011 from American College of Education in Chicago, Illinois. Kimberly obtained her Ed.D in educational leadership from the University of Florida in 2017 with the completion of this dissertation. Kimberly is a high school Assistant Principal with six years as an administrator and eleven years as a high school teacher, swim coach and journalism and student government advisor. She currently holds an active Professional Educators Educator Certificate in the State of Florida and a Professional Educator Certificate in the State of Colorado. In Florida, she is certified in Educational Leadership K-12 and School Principal K-12, History 6-12, Social Science 6-12, English 6-12, Middle Grades Integrated Curriculum 5-9. She is certified as a School Principal: All Levels in Colorado. Kimberly was a Teacher of Distinction in 2008 by the Collier County Education Foundation, received numerous honors from Columbia University for outstanding yearbook publications, and presented at the Learning Sciences International Robert Marzano National conference in 2016. Kimberly is a member of the Delta Epsilon Iota Academic Honor Society and the Golden Key International Honour Society. Kimberly has been married to J.R. Stalcup since 2001 and they have two sons: Brayden (born 2005) and Bryen, (born 2009). They reside in Erie, Colorado where they enjoy camping, skiing, snowboarding, whitewater rafting, paddle boarding, and anything outdoors.